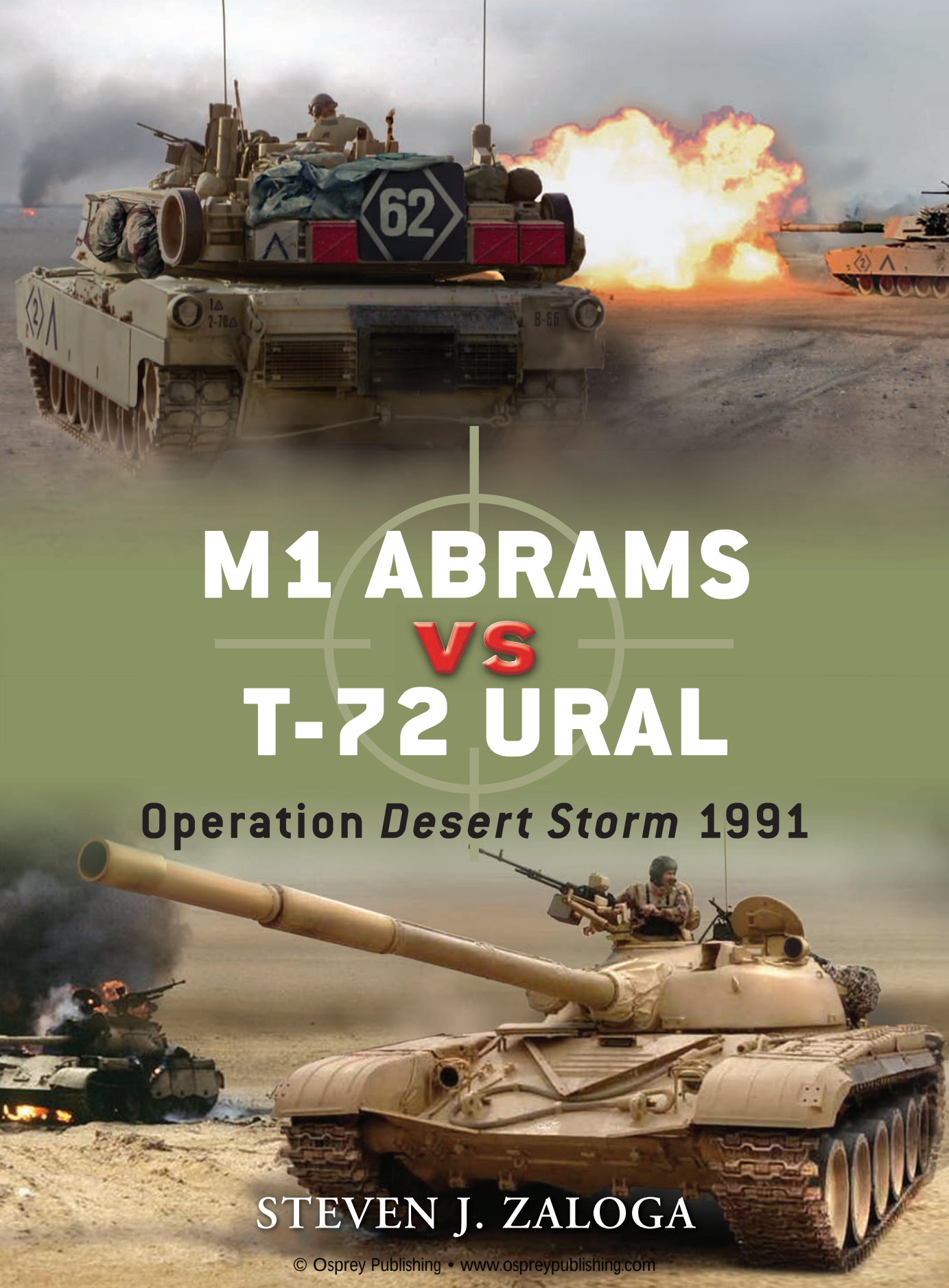

M1 ABRAMS VS T-72 URAL

Operation *Desert Storm* 1991

STEVEN J. ZALOGA

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Editor's Note

For ease of comparison please refer to the following conversion table:

1 mile = 1.6km

1lb = 0.45kg

1yd = 0.9m

1ft = 0.3m

1in = 2.54cm/25.4mm

1gal = 4.5 liters

1 ton (US) = 0.9 tonnes

Author's Note

The author would like to thank Prof Mark Gerges of the US Army's Command and General Staff College for his extensive help in recounting his experiences as an M1A1 Abrams tank company commander during Operation *Desert Storm*. I first met Mark more than decade ago when I attended his lecture about the 1st Armored Division in *Desert Storm*, sponsored by the New York Military Affairs Symposium. He had recently returned from service in the Gulf War and had been assigned to teach history at the nearby US Military Academy at West Point. Besides describing his experiences as a tank company commander to the NYMAS audience, he showed a videotape taken by his unit recording the battle of Medina Ridge. This videotape left a considerable impression on me as the clearest exposition of the nature of contemporary tank warfare I had ever seen. The battlefield was utterly empty windswept desert; the Iraqi tanks were more than 2km away and invisible to the naked eye. The only evidence of their presence came partway into the tape when small flashes dotted the horizon, followed by barely visible plumes of smoke. It was hardly the Hollywood depiction of modern war. So I was very pleased when Mark agreed to help out and recount his experiences once again for this book. I would also like to thank John Charvat, Stephen "Cookie" Sewell and Lee Ness for their help on this project.

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INTRODUCTION

The Cold War never turned hot, so the intriguing question remains: "How would NATO tanks have stacked up against Warsaw Pact tanks?" Other conflicts, fought away from the main theater, may hint at the answer. Operation *Desert Storm* of February 1991 provided a fascinating example of modern US versus Soviet-built tanks in action. This conflict was not a perfect surrogate for a NATO–Warsaw Pact clash since the latter had better tanks than the Iraqi T-72M1 and Warsaw Pact crews were probably better that the average Iraqi tank crews. Nevertheless, close examination of these tank battles provides an intriguing look at the state of tank technology and tank warfare at the end of the Cold War.

Desert Storm was not the first war which pitted US against Soviet equipment. The first significant clash occurred in Korea in 1950 when the North Korean Army spearheaded their attack on South Korea using Soviet-supplied T-34-85 tanks, and the US-led intervention involved M4A3E8, M26 and M46 tanks. Although the North Korean T-34-85 tanks proved to be highly effective in the initial invasion when faced with poorly trained South Korean infantry, once they were challenged by US Army tanks they suffered massive losses. The reasons were far less to do with the technology of the opposing tank types, which was fairly similar, but instead it was primarily crew quality which made the difference. The US crews were better trained than their North Korean opponents, and this core issue of crew competence would resonate through many later Cold War tank battles.

The 1956 war between Israel and Egypt involved tank combat between US-built Sherman tanks and Czechoslovak-supplied T-34-85 tanks, and once again the results were heavily dependent on crew quality. The 1967 Six-Day War saw the first major clash involving tanks developed after World War II. The Israel tank units largely relied on the British Centurion and US M48A2 Patton tanks while the Egyptian and Syrian

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forces used Soviet T-54 and T-55 tanks. However, the tank battles were one-sided in favor of Israel even when Israeli units used modified Sherman tanks, and the importance of crew performance was demonstrated especially clearly when Israeli Shermans successfully confrontated the modern Jordanian M47 and M48 tanks. The 1973 Arab–Israeli War saw yet another generation of Cold War tanks put to the test, in this case the US M60A1 and the new Soviet T-62. The results of this conflict were not as lopsided as some of the earlier wars, though ultimately, the Israeli tanks exacted a punishing kill-ratio against their opponents.

These wars could not provide an entirely accurate model for a potential NATO–Warsaw Pact tank confrontation due to differences in terrain, tactics, training and many other factors. But time after time, they suggested that the ultimate factor in deciding the outcome of tank combat was crew performance and not tank technology. The technical balance between NATO and Warsaw Pact tanks through most of the Cold War was close enough that it could not alone determine the outcome of tank fighting. This book will argue that the same was true about Operation *Desert Storm*. But it will also argue that *Desert Storm* provided an example where there was not only a clear advantage in crew quality on one side, but that there was a much greater technical disparity than was the case in most of the previous clashes.

The American M1A1 Abrams, German Leopard 2, British Challenger, and Soviet T-72 and T-80 were the ultimate tank designs of the Cold War years, and still have not been replaced by a new generation of tanks. Indeed, there is some question whether they will be replaced in the foreseeable future, since they continue to be viable battlefield contenders so long as they are well maintained and regularly updated. In recent years the focus has instead been on the adoption of a new generation of

The T-72 became the standard license-produced Soviet tank in the 1980s in Poland, Czechoslovakia, India, and Yugoslavia. Iraq was not the only army to use the T-72 in the 1991 war. The Kuwaiti 35th Fatah Brigade operated the Yugoslav-built M-84A version as part of the Joint Coalition Force Group. (US DoD)

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The M1A1 Abrams tank represented the culmination of a number of technological trends in the 1960s and 1970s, which included the introduction of a new generation of digital electronics. This provided substantially better accuracy at long range, the ability to fire on the move, and significantly improved capabilities to see at night and through smoke and fog. (GDLS)

lightly armored wheeled vehicles that are more economical for peacekeeping operations rather than high-intensity combat.

Several features distinguished the M1A1/T-72 generation from previous generations of tanks. In terms of firepower, these tanks represented the final switch to the use of APFSDS (armor-piercing, fin-stabilized, discarding-sabot) ammunition (simply termed "sabot" in the US Army) for tank fighting. While APFSDS had already been used by previous generations of tanks, HEAT (high explosive anti-tank) ammunition had remained the predominant type in NATO and Warsaw Pact use through the 1970s. APFSDS began to attract serious attention due to its extensive use by Syrian and Egyptian T-62 tanks in the 1973 Arab–Israeli War. The final triumph of APFSDS was due in part to advances in ammunition technology, but also to improvements in fire-control systems that gave APFSDS a level of accuracy

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resembling that of rivals such as guided tank projectiles. Both the M1A1 Abrams and the T-72 relied on APFSDS as their primary tank-fighting ammunition at the time of Operation *Desert Storm*.

The greatest disparity between the M1A1 Abrams and the T-72M1 was not in actual gun performance but rather in gun fire-control. The Abrams used a far superior FLIR (forward-looking infrared) thermal-imaging sight while the T-72 relied on the older and less versatile active infrared technology for night vision. The ultimate rule in tank fighting has always been "see first, fire first, hit first." It was the thermal sights on the M1A1 that provided the crucial combat edge in Operation *Desert Storm*, since US tanks could spot and engage Iraqi tanks before the US vehicles could be seen. Iraqi tanks suffered another significant disadvantage in 1991 in that they were supplied with inferior ammunition – a generation behind that used by the Russian army of the time.

In terms of armor, the M1A1/T-72 generation marked a distinct turning away from homogenous steel armor towards laminate armor. Laminate armor had been used since the 1960s in the glacis plates (the heavily armored sloping front of a tank's hull) of Soviet designs such as the T-64, but it had taken some time for armies to be convinced that laminate armor was worth the trouble compared to conventional steel armor. The M1A1 and T-72 provide some important clues to the advantages of the new generations of armor and their value on the modern battlefield. In this respect, the M1A1 held a critical edge over the export T-72M1, which had armor inferior to that of the Russian army's contemporary T-72B tank.

There was also an important contrast between the T-72 and M1A1 in terms of propulsion. At the time of these tanks' design there was heated debate about the relative value of conventional diesel engines against the new generation of gas-turbine engines. In the Soviet case both engine types were utilized – the T-72 had a diesel engine, the T-80 a gas-turbine one. The US M1A1 was powered by a gas turbine, but this remained one of the most controversial features of the tank. Operation *Desert Storm* did not silence this debate, despite the outstanding performance of the Abrams.

The M1 Abrams and T-72 Ural offer a curious contrast in terms of design and development paths. The M1 Abrams program constituted an entirely new effort aimed at producing the best tank possible, albeit within a tight budget. The T-72, on the other hand, was a reinterpretation of the existing T-64A, arising from industrial rivalries within the Soviet Union.

Despite the vehicles' relative technical merits and flaws, the outcome of the tank battles of *Desert Storm* hinged as much on tactics, terrain, and crew capabilities as on the machines themselves. The Iraqi army was a mass conscript force that had become oversized as a consequence of recent wars; the army sacrificed quality for quantity in a bid to overcome Iran. The US Army had gone through a decade of reform and was now a lean professional force that had been honed to a sharp edge for potential combat in central Europe. By far the greater disparity between the two armies lay in their quality of troops than in the quality of technology.

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CHRONOLOGY

1968
January Start of development of T-72.

1972
February Start of development of M1 Abrams.

1973
August Official state acceptance of T-72.
November Start of production of T-72.

1975
Start of production of T-72 Model 1975 export tank in USSR.

1976
November Start of engineering development of M1 Abrams.

1979
May Production approval of M1 Abrams. Start of production of T-72A tank.

1980
February First delivery of series production M1 Abrams.
September 22 Iraq attacks Iran.

1981
Start of production of T-72 Model 1975 tank in Poland.

1982
Start of production of T-72M1 export tank in USSR.

1984
October First delivery of series production IPM1 Abrams.

The best version of the T-72 in Iraq in 1991 was the T-72M1, like this example captured from the Hammurabi RGFC Armored Division and subsequently put on display at Fort Stewart, Georgia. It has the characteristic features, including upgraded turret armor, smoke dischargers, a thermal sleeve on the gun, and appliqué armor on the hull glacis plate. (Author)

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The final tank combat of Operation *Desert Storm* occurred after the ceasefire on March 2, when the Hammurabi Division bumped into the US 24th Infantry Division while trying to escape, leading to the short but intense "Battle of Rumalyah." This is an M1A1 of Company C, 4–64 Armor, during the fighting. (US Army)

1985

Start of production of T-72M tank in Poland and Czechoslovakia.
Start of production of T-72B in USSR.

August First delivery of series production M1A1 Abrams.

1986

Start of production of T-72M1 in Poland and Czechoslovakia.

1987

Start of production of T-72S export tank in USSR.

1988

August 20 Official ceasefire halts Iran–Iraq War.

October First delivery of series production M1A1HA Abrams.

1990

August 2 Start of Iraqi invasion of Kuwait.

1991

January 17 Start of coalition air campaign against Iraqi forces in Kuwait.

February 24, 0600 hours
G-Day – start of coalition ground campaign against Iraq.

February 26, 1500 hours
2nd ACR starts Battle of 73 Easting.

February 27, 1200 hours
1st Armored Division starts Battle of Medina Ridge.

February 28, 0800 hours
Ceasefire.

March 2 Hammurabi Division bumps into 24th Infantry Division, starting Battle of Rumalyah.

Capt Mark Gerges, commander of Bravo Company, 2–70 Armor, is seen here inspecting a destroyed BMP-1 at the Medina Ridge battlefield, which his team revisited in March 1991 to further examine the conduct of the battle. Gerges was awarded the Bronze Star and the Bronze Star with Valor device for his service during Operation *Desert Storm*. (Mark Gerges)

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DESIGN AND DEVELOPMENT

M1A1 ABRAMS

In the 1970s, the US Army tank force was based on the M60A1, with some of the older M48A3 Pattons still in service with National Guard units. Both tanks were evolutionary descendants of the M26 Pershing tank of 1945. An attempt to replace the Patton series with the more radical T95 design failed by 1959 as did the subsequent American–German MBT-70 program in the 1960s. Frustrated by cost overruns and poor performance, the US Congress killed the remnants of the MBT-70 program in 1971 and instructed the army to make another fresh start. In the meantime, the M60A1 soldiered on through evolutionary improvements as the M60A3 (TTS), with important innovations including a laser rangefinder, thermal-imaging nightsight, and a new generation of ammunition.

In contrast to previous tank development programs, which had relied on the US Army's Tank-Automotive Command to undertake most of the design work, the new XM1 program was competitively developed by US industry. In 1972 General Motors and Chrysler received contracts to produce pilots of the XM1. The army did not want a repeat of the situation with the overly complicated MBT-70, and the price per unit was capped at $500,000; by way of comparison, at the time a single M60A1 tank cost $339,000. Due to time constraints, the army decided to stay with the existing 105mm gun instead of the more powerful German 120mm gun being developed for the Leopard 2, with provision for the 120mm weapon to be adopted at a later date.

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The 2nd Armored Division at Fort Hood, Texas, was one of the first units equipped with the new M1 Abrams tank in 1982–83, including these examples from 3–67 Armor. (Author)

One of the main innovations in the M1 Abrams design was the incorporation of laminate armor. The US Army had been studying various types of advanced armors since the 1950s, and in 1972 the British government agreed to share details of its breakthrough Burlington special armor – often referred to as "Chobham" armor, since it was developed by the Fighting Vehicle Research and Development Establishment at Chobham. The primary aim of laminate armor was to defeat shaped-charge HEAT (high-explosive anti-tank) warheads which had become a principal tank-killer through their widespread use in anti-tank missiles as well as projectiles fired by tank guns. With conventional high-explosive warheads the explosive energy is released in all directions. In contrast, a shaped-charge warhead is built around a hollow metal cone and when detonated, the explosive crushes the cone and forms it into a hypervelocity stream of metal particles which can penetrate a significant depth of armor. Experiments had shown that the penetration effect of shaped-charge warheads could be weakened using laminates. As the hypervelocity stream penetrated the layers it tended to break up or be diverted, lessening penetration. In the case of the M1 the protection objective was to shield the front of the tank against both the Soviet 115mm APFSDS projectile and a US 5in (127mm) HEAT warhead comparable to that used in Soviet anti-tank missiles.

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The XM1 designs also began to explore other methods of protecting the crew besides the armor package. The primary cause of catastrophic tank loss in combat is the ignition of main gun ammunition propellant. Since World War II, tank designers had advocated transferring the ammunition to the floor of the tank where it was least likely to be hit, in order to minimize this hazard. However, this configuration does not guarantee that the ammunition will not be hit since mine damage or ricocheting projectile fragments inside the tank can still set it on fire. Furthermore, the floor location makes it difficult for loaders to reach and handle the ammunition – especially in view of the growing weight and size of modern tank ammunition. The US Army began to explore the idea of moving the ammunition into a bustle at the rear of the turret. The ammunition compartment would be separated from the fighting compartment by sliding blast-doors, and only open for a short time when the loader extracted a round. Should the ammunition be set on fire, the blast-doors would protect the crew long enough for the men to escape, and in many cases would slow or prevent the spread of a catastrophic fire into most of the tank.

One of the most controversial features of the XM1 was its propulsion. In the 1960s the army had sponsored the development of a gas-turbine tank engine – the AVCO-Lycoming AGT-1500, originally considered for the MBT-70 – in place of more conventional diesel engines. The army's enthusiasm for the gas-turbine option stemmed from the revolutionary improvements in gas-turbine propulsion in army helicopters. A gas turbine is a form of jet engine, but with the power output through a transmission rather than a jet exhaust. Gas turbines were significantly smaller and lighter than contemporary piston engines of comparable power. In helicopters, their simplicity resulted in lower maintenance demands and greater reliability. However, some notable challenges did arise in adapting gas turbines to tanks. A major one was their voracious consumption of fuel and air. Unlike conventional piston engines,

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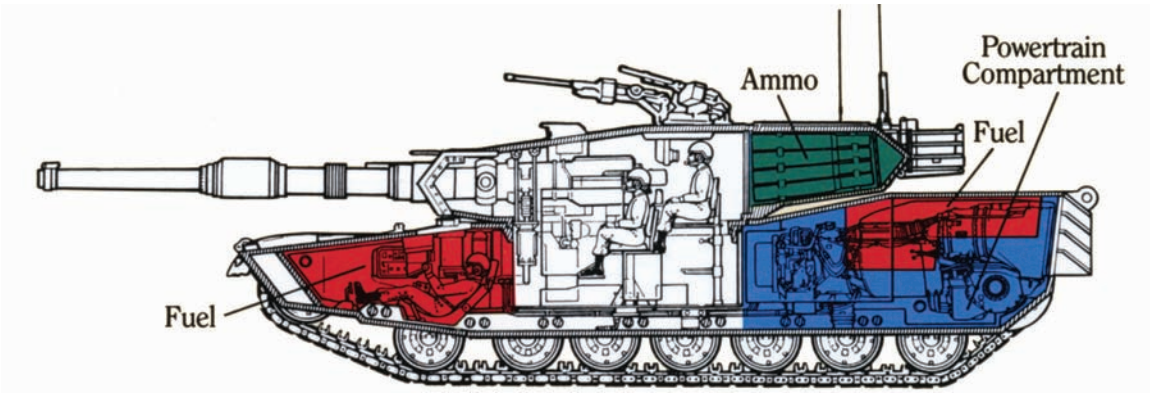
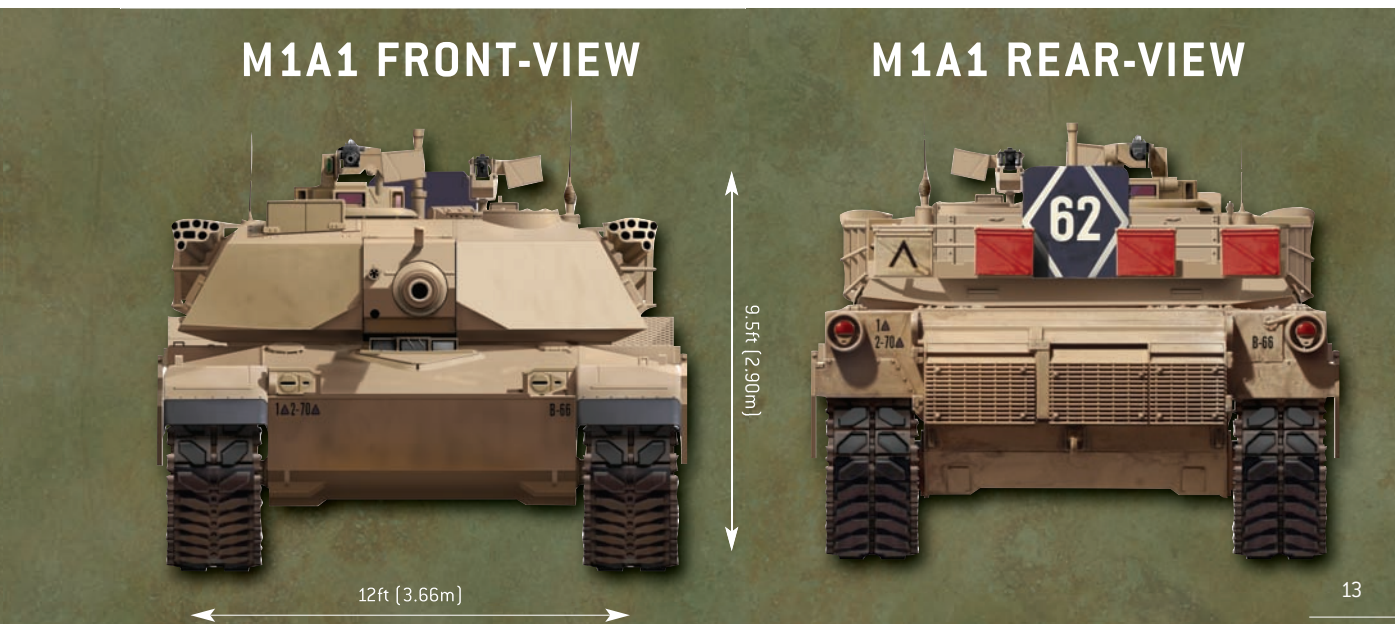


An interior cross-section drawing of the M1A1 Abrams showing the compartmentation of the tank. (GDLS)

which can be slowed to idle to conserve fuel when the tank is not moving, the gas turbine operates near peak power all the time, consuming fuel. In addition, the engine requires a substantial flow of air – a more significant problem in a land-combat environment than in the case of helicopters, due to the presence of dust which can erode engine parts. In the end, Chrysler selected the more controversial turbine for its XM1 design while General Motors stuck with an AVCR-1360 diesel. Although both engines were rated at 1,500hp, the actual amount of power available from the turbine was greater since only about 30hp had to be diverted to engine cooling compared to about 160hp for the diesel. Both tank designs were subjected to extensive testing during 1976, but neither emerged as a clear winner. The army originally favored the General Motors design, but at the same time wanted the AGT-1500 turbine. However, a plan to award the contract to General Motors with instructions to reconfigure the tank for the AGT-1500 was rejected by the Secretary of Defense. As a result, the



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contract was re-bid with General Motors being pressured to modify the design to accommodate the AGT-1500 and both potential contractors were instructed to modify their turret design to accommodate the German 120mm gun.

Chrysler's efforts at cost reduction paid off, and the full-scale engineering-development contract was awarded to the firm in November 1976. Low-rate initial production was approved in May 1979 and the first production tank was delivered in February 1980. The new tank was named after Gen Creighton Abrams, who had commanded M4 Sherman tanks in World War II, had been army chief of staff in the later years of the Vietnam War, and was an ardent advocate of the new tank. The new AFV was formally type-classified as the M1 in February 1981 and full production was authorized with a procurement objective of 7,058 tanks. During the course of production, Chrysler's defense division was purchased by General Dynamics, becoming General Dynamics Land Systems (GDLS).

No sooner had the M1 entered production than the army decided to press ahead with the M256 120mm gun – a simplified copy of the German Rheinmetall weapon. By this time it was obvious that the 105mm gun would be inadequate to deal with the newer generation of Soviet tanks such as the T-64B and T-80B. The first M1E1 pilots with the 120mm gun were delivered in March 1981; these pilots incorporated a

The final version of the M1A1 to arrive in time for combat during Operation *Desert Storm* was the M1A1 Common tank, developed to incorporate special Marine requirements such as the wading trunks needed for amphibious landing operations. (GDLS)

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M1A1 ABRAMS SPECIFICATIONS

M1A1 Abrams, 2–70 Armor, 1st Armored Division, Medina Ridge, Iraq, February 1991

General

Crew: Four
Overall length: 32.2ft
Hull length: 26ft
Width: 12ft
Height (to top of machine-gun): 9.5ft
Ground clearance: 1.6ft
Track contact: 15ft
Track width: 2.1ft
Gunner's night vision: Hughes thermal-imaging sight
Driver's day/night vision: Day periscope/image intensification night vision
Commander's day/night vision: Periscopes, optical elbow to gunner's primary sight
Fire protection: Automatic halon
Procurement cost: $1,624,000 (1988)

Motive power

Engine: 1,500hp Avco-Lycoming gas turbine
Fuel capacity: 505gal

Performance

Maximum road speed: 41mph
Fording capacity: 4ft without kit, 7.5ft with kit
Obstacle clearance capacity: 4ft
Power-to-weight ratio: 23.1hp/t
Ground pressure: 14.4psi

Armament

Main armament: 120mm M256 smoothbore gun
Main gun rate of fire: 6rpm
Main gun stabilization: Azimuth in turret, elevation in line-of-sight
Main gun elevation: -10 to +20 degrees
Secondary armament: M240 7.62mm co-axial machine-gun
Anti-aircraft defense: .50cal Browning heavy-barrel; M240 7.62mm
Smoke dischargers: Grenade launcher

variety of other improvements, most notably an improved armor package. Details of the latter package remain confidential, but a Soviet report assessed the armor protection for the M1A1 against APFSDS as equivalent to 600mm RHA (rolled homogenous armor) compared to 470mm for the M1, and 700mm against HEAT compared to 650mm for the basic M1. These features, minus the 120mm gun, were incorporated into the M1 production line with the confusingly named IPM1 (Improved-Performance M1); 894 of the latter were delivered between October 1984 and May 1986. The 120mm version of the Abrams was type-classified as the M1A1 in August 1984 and the first production tanks were completed in August 1985. Priority for the new version went to US Army Europe (USAREUR), which had begun receiving them in large numbers by 1988.

During the late 1980s development of laminate armor packages for the Abrams continued, including a configuration using depleted uranium – that is, metallic uranium consisting of isotopes that emit little or no radiation. The principal advantage of uranium is its weight and density, which is about double that of lead. Depleted uranium was employed in a third generation of armor on the M1A1, leading to a variant dubbed the M1A1HA (HA standing for "Heavy Armor"). Besides being incorporated into new production tanks – starting in October 1988 – the heavy armor package could also be retrofitted to existing tanks. The M1A1 and M1A1HA were the principal types of Abrams used in the 1991 Gulf War.

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T-72M1 URAL

The dynamics of the T-72 program were fundamentally different to those of the M1 program, and it was arguably less successful. A primary focus of Soviet tank development since the mid-1950s had been the Aleksandr Morozov design bureau's development of a new-generation tank at the tank plant at Kharkov (now Kharkiv in the Ukraine). This bureau had been associated with the legendary T-34 design, and before Kharkov was overrun by the Wehrmacht in 1941 the plant and associated design bureau were moved out of reach to Nizhni-Tagil in the Urals. There, the bureau was given responsibility for the next generation of Soviet tanks: the short-lived T-44 and the more successful T-54. The Morozov bureau returned to Kharkov in 1951 and began work on another new-generation tank, *Obiekt* 430. A small engineering team remained behind at the Uralvagon plant in Nizhni-Tagil to manage further evolution of the T-54 tank, starting with the T-55. This latter kernel would in the 1950s grow into a separate tank design bureau, headed by L. N. Kartsev, which would begin to rival the original Kharkov bureau.

Morozov's dream was to repeat the success of the T-34 with a revolutionary new tank that would match NATO tanks in firepower, armored protection, and mobility while remaining significantly lighter and more economical. The latest design went into production on a small scale in October 1963, as the T-64 tank. The T-64 incorporated a host of novel features including laminate armor in its glacis plate and an autoloader for its main gun. However, the design was plagued by problems, especially the poor reliability of its opposed-piston diesel engine. While Morozov was trying to cure the problems with the T-64, Kartsev's Uralvagon bureau had stretched the T-55 to accommodate a 115mm gun like that on the T-64. The resulting T-62 tank, while not offering the armored protection or sophistication of the T-64, was much more economical to build and much more dependable. As a result of the continuing tribulations of the T-64, the simpler and less expensive T-62 became the more widely manufactured tank of the 1960s.

Morozov continued to work on solving the problems with the T-64's powerplant as well as improving its combat performance by incorporating a more powerful 125mm gun. The improved T-64 went into production in May 1968 as the T-64A. However, while reliability had improved over the dismal T-64, the mean time between engine failures was still only about 300 hours. The Soviet Army had hoped to standardize on the T-64A as its new standard tank (*osoboviy* tank), a concept that combined the heavy armor and firepower of heavy tanks with the size and weight of medium tanks.

In the meantime, the Kartsev bureau at Uralvagon had continued to plan the evolution of the T-62. The team investigated using a new type of suspension with smaller road wheels and return rollers, and also began work on an autoloader for either a 115mm or 125mm gun. These features along with other design innovations were incorporated into the Obiekt 166 and Obiekt 167 tanks. On August 15, 1967, the Uralvagon plant was informed that it would transition from the manufacture of the

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T-62 tank to the T-64A tank in 1970. Two variants were envisioned: the basic T-64A with the troubled 5TDF diesel engine, and a "mobilization" version using a normal diesel engine from the T-62, which was intended as a low-cost alternative in the event of war. Kartsev hoped to develop a rival to the troubled T-64A, but was firmly rebuffed by Moscow. The political chief of the defense industry, Dmitriy Ustinov, continued to back the elegant and futuristic T-64A as the way of the future. In spite of Ustinov's continued preference for the Kharkov option, the Minister of Defense Industry, S. A. Zverev, had been impressed by a demonstration of the Uralvagon autoloader, and on January 5, 1968, instructed Kartsev's bureau to continue working on a mobilization version of the T-64A tank with the bureau's own autoloader and the improved V-45 diesel engine. This version, designated Obiekt 172, comprised a T-64A hull and turret reconfigured for the new autoloader and cheaper powerplant. Two examples were completed by the late summer of 1968. Comparative testing during 1969 uncovered a number of design flaws, but the results of trials had been sufficiently promising for Uralvagon to be authorized to build 20 prototypes. The delicate running gear of the T-64A remained a source of mechanical problems.

The rivalry between factions in the industry and the army supporting Kharkov and Nizhni-Tagil continued unabated in the late 1960s. The preference of senior army commanders for the simpler and more reliable Uralvagon approach counterbalanced the influence of Ustinov and the Kremlin bureaucracy. In the midst of the controversy, Kartsev was transferred from Uralvagon to an army tank research institute and his place was taken by V. N. Venediktov. On May 12, 1970, a state decree on standardizing the T-64A gave Uralvagon permission to develop a further elaboration of the Obiekt 172 which took it even further away from the T-64A configuration by permitting incorporation of the new suspension from the Obiekt 167. This version was designated Obiekt 172M, and a prototype was ready by the end of 1970.

The first of the T-72 export variants was the T-72 Model 1975, like this example from the Iraqi 3rd Saladin Armored Division, captured in 1991 by the US Marine Corps and subsequently displayed at Quantico, Virginia. The most characteristic feature of this version is the use of a coincidence rangefinder with the optical port in the protrusion in front of the commander's cupola. (Author)

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Curiously enough, a similar battle was being waged in Leningrad over plans to convert the plant there to T-64A production. The alternative approach here was to go one better than Kharkov and adopt a more powerful gas-turbine engine, a decision that would prove every bit as problematic as the opposed-piston 5TDF. In the event, by 1971 the Soviet tank industry had three new "standard" tanks on hand – the original T-64A, and two derivatives, ready for trials, Obiekt 172M (T-72) and Obiekt 219 (T-80).

A pre-production batch of 15 Obiekt 172Ms was completed by the summer of 1972 and subjected to a grueling field trial in June–October 1972. Overall, the army was very impressed by the durability and firepower of the Obiekt 172M. Ustinov continued to oppose production of the Uralvagon tank, but the army continued to press for its manufacture due to lingering reliability issues with the T-64A and the immaturity of the new Obiekt 219 (T-80). To settle the matter, the Kremlin ordered the creation of a special commission under the First Deputy Minister of Defense, Marshal I. I. Yakubovskiy. By this stage a second pre-production batch of Obiekt 172Ms had been completed, in which most of the problems found in the 1972 trials had been rectified, so the commission recommended production. On August 7, 1973, Obiekt 172M was accepted for army service as the T-72 standard tank; in 1975 it was named the T-72 Ural after its birthplace in the Ural mountain region. The initial production series of 30 vehicles was completed by the end of 1973, with 220 more completed in 1974.

In April 1976 Defense Minister Marshal Andrei Grechko died and his place was taken by Ustinov, who had never favored the T-72 and referred to it as a "step backwards in Soviet tank development." Since the production debates of 1970–72, his support had shifted from the troubled T-64 to a new champion – the gas-turbine-powered T-80, developed by a consortium of Leningrad concerns with powerful

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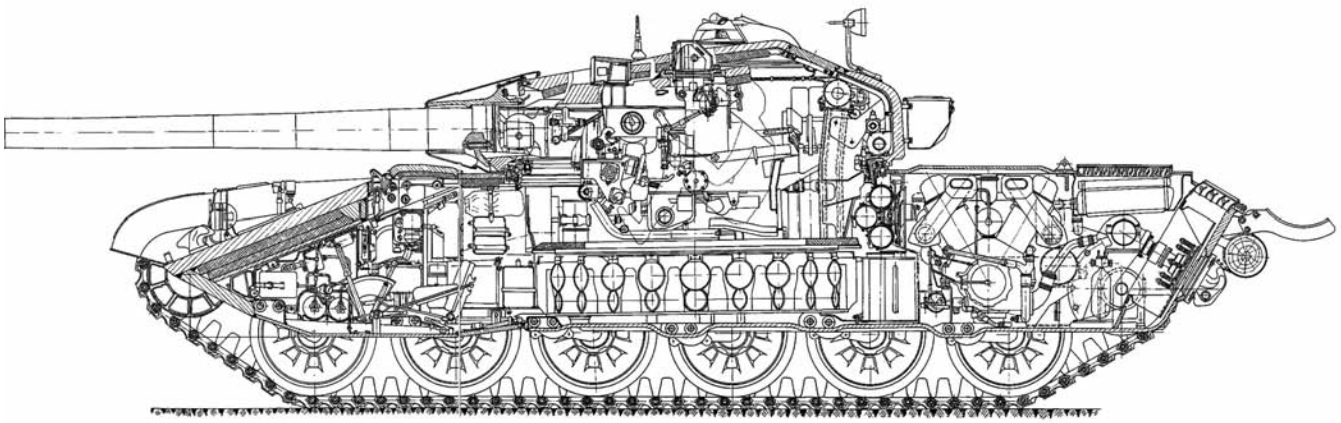
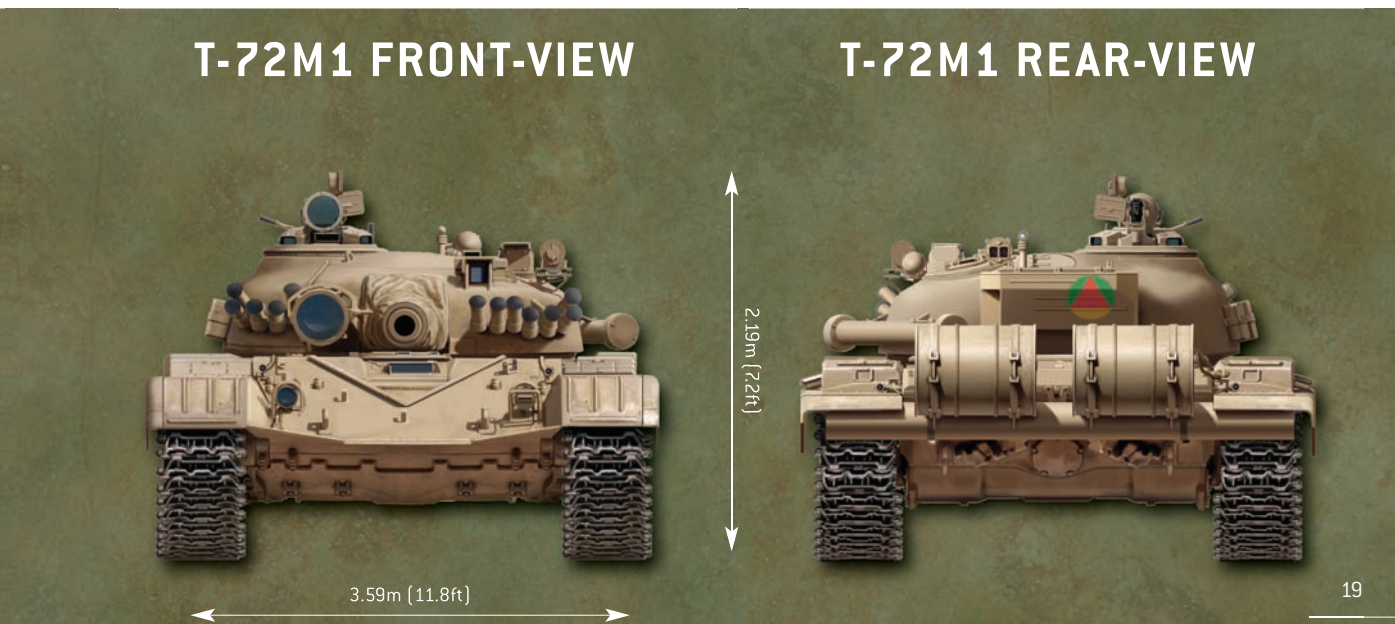
political connections within the Kremlin. As a result, Ustinov put a cap on T-72 advances. The T-64 and T-80 would serve as the premier Soviet standard tanks with forward-deployed units facing NATO in Germany and would receive priority for technological innovations in fire-control and advanced protection, while the T-72 would be used for second-line units in the Soviet Union as well as for export.

The T-72 underwent continual evolution during production. The second production series, Obiekt 172M sb-1A, incorporated several modest changes and can be distinguished from tanks of the early production series by the shift of the Luna infrared searchlight from the left side to the right side of the gun. This version, sometimes called the T-72 Ural-1 Model 1976, was in series production at Nizhni-Tagil from 1975. A command-tank version, the T-72K Ural-K (Obiekt 172M sb-2), was next in the

Interior cross-section of the T-72 tank.





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development cycle, and was similar to the T-72 Model 1976 except for the added radio and navigation system.

The original T-72 versions through 1977 used laminate armor in the glacis plate, but had a conventional "monolithic" cast-steel turret. The laminate glacis plate comprised an initial layer of 80mm high-carbon steel armor, followed by 105mm of GRP (glass-reinforced plastic or *stekloplastika*) about a quarter of the density of the steel, and finally a 20mm layer of high-carbon steel. The contemporary T-64 variant, the T-64A, also used laminate glacis armor but instead of the monolithic steel turret was fitted with a special-armor turret which had a large cavity in the front that was filled with aluminum. The monolithic steel turret of the T-72 was about two percent better at resisting APFSDS attack while the T-64A turret was about ten percent better against shaped-charge attack. However, firing tests discovered that the T-64A's apparent advantage was less than it seemed because after a single hit the cavity tended to deform and lose its protective advantage. The next generation of special armor used a Combination K (K for *korundum*, or ceramic) layer in the turret. The original configuration developed by NII Stali (the State Research Institute for Steel) used ceramic balls in an aluminum matrix. Although this went into production for the T-64A in 1975, it was difficult to manufacture and was soon replaced by a modified version using ultra-porcelain (*ultrafarforov*) ceramic rods instead of balls, also sometimes called "sandbar armor."

The new turret special armor with ceramic-rod filler was first used on an interim version of the T-72 series, the T-72 Model 1978 (Obiekt 172M sb-4), which entered

The T-72M1 was by no means equivalent to the best Soviet tanks of the early 1990s. The best T-72 variant at the time was the T-72B with *Kontakt* reactive armor; pictured is an example of the T-72S export version, on display at the Nizhni-Novgorod Yarmark arms show in September 1996. Iran subsequently bought this version, which had substantially better armor than the T-72M1 as well as better ammunition. (Author)

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production in 1977. Besides the new turret armor, this version also incorporated a switch from an optical-coincidence rangefinder to the TPD-K1 laser rangefinder. However, this version was relatively short-lived, being supplanted by the T-72A Model 1979 (Obiekt 172M sb-6, later Obiekt 176) which represented the first substantial redesign of the T-72 family. This used the new ceramic-rod turret filler and TPD-K1 sight, but also incorporated improved glacis laminate armor, new anti-shaped-charge sideskirts, an improved suspension with more travel for the road wheels, the improved 2A46 gun, and the *Tucha* smoke dispensers. This version was accepted for service in June 1979. The next production series, the T-72A Model 1983, introduced anti-radiation cladding on the turret roof and several other changes, including the 16mm glacis appliqué mentioned below. This version was in production through early 1985.

The third generation of the T-72, the T-72B (Obiekt 184), introduced a substantially improved form of turret laminate armor as well as improvements in the glacis plate armor. This was prompted in large measure by lessons from the 1982 Lebanon war. Syria provided the Soviet Union with some captured Israeli tanks and ammunition, and an Israeli M48A5 with the new M111 APFSDS ammunition was sent to the Kubinka proving ground near Moscow for firing trials against a T-80. The Soviet engineers were shocked to discover that the M111 could penetrate the multi-layer glacis armor. This led to a series of improvements to the armor on the T-64, T-72 and T-80, as well as a crash program to retrofit a steel appliqué plate to existing tank glacis to provide protection against projectiles comparable to the M111. The T-72B and later Uralvagon derivatives such as the T-90 will be passed over in this account, since they did not play a role in Operation *Desert Storm*.

In 1976, Ustinov decided to earmark the T-72 as the next export tank for Soviet clients in place of the T-62, notably for Warsaw Pact allies. In general, the Soviet practice was to allow export clients to build T-72 variants about a generation behind their Soviet counterparts in terms of armor protection and fire-control systems. The

The Iraqi army introduced a number of local modifications, as seen here on the turret of a Medina 2nd Armored Brigade T-72M1 knocked out at the Battle of Medina Ridge. A shelf has been added to the left of the gunner's hatch for an anti-missile jammer, although the jammer itself has been knocked off by the explosion (an intact jammer is illustrated later). Both infrared searchlights have had armored covers added over them to reduce their vulnerability to small-arms and artillery damage. (Mark Gerges)

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An Iraqi T-72M1 engaging targets on the Besmaya Gunnery Range outside Baghdad in October 2008. The reconstituted Iraqi Army still uses the T-72M1 tank, though most are newly acquired, reconditioned tanks obtained from former Warsaw Pact countries. (US DoD)

associated ammunition was also a few years behind the Soviet standard. In 1977 Ustinov visited India, and a tentative agreement was signed to sell the latter country 5,000 T-72 tanks and help it set up a T-72 plant. In the end, this deal was not completed on schedule due to political changes in India, but it did accelerate the process of preparing the T-72 for the export market. The first T-72 export tank manufactured at Uralvagon was internally designated as Obiekt 172M-E, (E for *Eksportniy*, or Export). By the time the Indian deal was under discussion, the Soviet government was also encouraging Poland and Czechoslovakia to begin license production and agreements were reached in 1978. Production of the T-72 Model 1975 export tank began at the Bumar-Labedy plant in Poland in July 1982 and at the Martin plant in Czechoslovakia in 1982. There were two versions of this tank built – the Obiekt 172M-E with the standard Soviet PRKhP and FTP-100M nuclear/biological/chemical (NBC) protective suite intended primarily for Warsaw Pact armies, and the Obiekt 172M-E1 with a modified protective system using hermetic sealing and a turboseparator intended primarily for export to Middle Eastern countries, including Libya, Algeria, Syria, and Iraq.

The second export version, the T-72M (Obiekt 172M-E2), began development in 1978, with production for export clients beginning at Nizhni-Tagil around 1980 and in Poland and Czechoslovakia by 1985. The T-72M was a hybrid of the Soviet T-72 and T-72A in terms of features. For example, it used the TPD-K1 laser rangefinder as found on the T-72A, but was still fitted with the monolithic steel turret. The initial production version, the Obiekt 172M-E2, had the original 2A46 125mm gun without the thermal shield and still carried the basic ammunition load of 39 rounds for the main gun. This version was followed by the Obiekt 172M-1-E3, which added a thermal sleeve to the 125mm gun, increased ammunition stowage from 39 to 44 rounds, introduced the improved TNP-1-49-23 nightsight in place of the earlier TNP-1-49, added the *Tucha* smoke grenade launchers to the front of the turret, and added the anti-HEAT sideskirts. In parallel, the Obiekt 172M-1-E4 was built for export outside of the Warsaw Pact and was essentially similar to the E3 except that it was fitted with the same NBC protective suite as the export T-72 (Obiekt 172M-E1).

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The T-72M was finally cleared for the use of special armor in the turret in 1982; the resulting T-72M1 export tank was a close relation to the Soviet T-72A. This version had the improved turret front armor using ceramic rods and an upgraded glacis plate with 16mm steel appliqué. There were numerous other upgrades compared to the T-72M, including better shock absorbers and an improved driver's hatch. Production of the T-72M1 began in Poland and Czechoslovakia in 1986. Two basic versions were manufactured – the Obiekt 172M-1-E5 for the Warsaw Pact, and the Obiekt 172M-1-E6 for export outside Europe with the alternative NBC protective suite. The main client for the Obiekt 172M-1-E6 was India, which built the model locally under license as the T-72M1 *Ajeya*.

These export variants are significant in the case of Iraq, since all Iraqi T-72s were export models – including the T-72 (Obiekt 172M-E1), T-72M (Obiekt 172M-1-E4) and T-72M1 (Obiekt 172M-1-E6). Iraq purchased its first batch of 100 T-72 Ural-1s (Obiekt 172M-E1) from the USSR in 1979–80. Following the outbreak of the war with Iran, the USSR restricted its sales to Iraq since it was also courting Iran; however, the USSR encouraged its Warsaw Pact allies to take its place. Thus, in 1982

T-72M1 SPECIFICATIONS

T-72M1, 2nd Armored Brigade, RFGC Medina Armored Division, Medina Ridge, Iraq, February 1991

General

Crew: Three
Overall length: 9.53m
Hull length: 6.86m
Width: 3.59m
Height to turret roof: 2.19m
Ground clearance: 0.49m
Track contact: 4.29m
Track width: 580mm
Gunner's night vision: TPN-1-49-23
Driver's day/night vision: TNPO-168 and TVNE-4B (active IR/passive II)
Commander's day/night vision: TNP-160 and TKN-3
Commander's searchlight: OU-3GKM with IR filter
Fire protection: Automatic freon system, nine detectors
Unit price: $1,200,000; $1,800,000 with ammunition and spares (1992 export)

Motive power

Engine: V-46-6 12-cylinder diesel, 780hp (575kW) at 2,000rpm
Fuel capacity (internal + external): 705 liters + 495 integral; +400 liters in two fuel drums

Performance

Maximum road speed: 60km/h
Fording capacity: 1.2m without preparation, 5.0m with preparation
Slope-handling capacity: 30° gradient, 25° side-slope
Obstacle-handling capacity: 0.85m vertical, 2.9m trench
Power-to-weight ratio: 19.8hp/t (14kW/T)
Ground pressure: 0.9kg/cm^2

Armament

Main armament: 2A46M (D-81TM) 125mm smoothbore gun
Main gun rate of fire: 8rpm (autoloader), 2rpm (manual)
Main gun stabilization: 2E28M electro-hydraulic, two-axis
Main gun elevation: -6 to +14
Secondary armament: Co-axial PKT 7.62mm machine gun
Anti-aircraft defense: 12.7mm NSVT *Utes* machine gun
Smoke dischargers: Type 902A *Tucha*; 12 cover 300m^2 for two minutes
Crew self-defense: AK-47S assault rifle, ten F-1 grenades

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Old enemies, new friends. This is an interesting view showing the Abrams side-by-side with the T-72, though in this case nearly two decades after Operation *Desert Storm* and in very differennt circumstances. This photos was taken on October 31, 2008 at the Besmaya Gunnery Range outside Baghdad showing joint training of US and Iraqi forces. Around this time, the US government announced plans to provide the new Iraqi Army with M1A1 Abrams tanks as part of their rebuilding effort. (US DoD)

Poland sold Iraq a batch of 250 T-72Ms (Obiekt 172M-1-E4), followed in later years by the improved T-72M1 (Obiekt 172M-1-E6). Iraq purchased a total of 1,038 T-72s of all types, mostly from Poland. In the late 1980s there were plans to begin T-72M1 production at Taji in Iraq in cooperation with Bumar-Labedy. The process was to begin in 1989 using knockdown kits from Poland, with the locally assembled tanks called *Asad Babil* ("Lion of Babylon"). There are conflicting accounts regarding how many, if any, were actually completed. Polish officials indicate that none were completed even though a T-72M displayed at an Iraqi arms show in 1988 was claimed to be a locally built tank. In the event, LtGen Amer Rashid pushed for complete manufacture of the T-72M1 in Iraq rather than simply assembly from knockdown kits. In 1991 Bumar-Labedy was upgrading the Taji facility, but during the course of the war Taji was destroyed by air attack.

As a result of the USSR's export policy, clients such as Iraq did not receive tanks comparable in quality to the best Soviet tanks. In 1990 the best Iraqi version of the T-72 was the T-72M1 – roughly equivalent to the Soviet T-72A, which was already a decade old and not as well armored as the newer T-72B or the preferred T-80B series. Just as importantly, the Soviet Union did not export its best tank ammunition: the Iraqi army relied primarily on second-rate ammunition for its T-72 tanks.

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TECHNICAL SPECIFICATIONS

The vagaries of Soviet tank design in the 1960s led to a host of standard tanks that were substantially smaller and lighter than their NATO counterparts. A combat-laden T-72M1 weighed 41.5 tonnes compared to 56.8 tonnes for the M1A1 – thus being one-third lighter. One of the most immediate results of this was the amount of internal space for the crew. The T-72M1 is extremely cramped, especially in the driver's compartment, with conditions being only marginally better in the turret. The M1A1, while not as spacious as the previous M60A3 tank, was positively luxurious compared to the T-72 with ample space for the loader and the rest of the crew. While this may seem irrelevant to tank design, it reflects the relative inattention of Soviet designers to crew ergonomics and the impact of these features on combat performance. The T-72M1 was not well suited to prolonged combat operations in desert climates because the extremely restricted space within the vehicle led to overheating, crew fatigue and excessive crew stress. Although Operation *Desert Storm* was fought during the winter months, temperatures even during February were sometimes warm enough to negatively affect crew performance. "Air conditioning" in the T-72 was provided by a small, unshielded plastic fan. This might be adequate in Russian or European climes, but was of dubious value in the desert.

PROTECTION

Modern main battle tanks have their best armor towards the front, with the usual design requirement being for them to provide optimum protection in the forward

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In the M1A1 the crew is protected from the risk of ammunition fire by a hydraulically operated blast-door that separates the ammunition stowage in the bustle from the crew compartment. The loader opens the door using a knee pedal, so as to keep his hands free while transferring ammunition to the gun breech. (Author)

60-degree sector. This involves an inevitable design compromise, since it is impossible to provide equivalent protection in all directions while remaining within viable weight limits. As a result, in this text the focus is on frontal protection for these two tanks; the side and rear protection is inevitably significantly less. Most contemporary assessments of tank protection distinguish between protection against APFSDS projectiles versus shaped-charge (HEAT) warheads, since modern laminate armors offer different levels of defense against these two distinctly different threats. The level of protection is usually expressed as equivalent to a certain thickness of rolled homogenous armor (RHA). It should be borne in mind that information on armor protection is still widely regarded as sensitive, so the data here cannot be regarded as definitive. The figures on T-72 protection are from official published Russian sources.

In general, the T-72 and T-72M were designed to be able to resist an strike equivalent to the Soviet 115mm tank gun firing a steel APFSDS projectile. This was considered roughly equivalent to the NATO 105mm gun of the time. The defense against HEAT was proof against a shaped charge roughly equivalent to the Soviet 9M14 *Malyutka* (AT-3 Sagger), which was viewed as equivalent to NATO types such as TOW; curiously enough, this was the same threat level for the original M1 Abrams tank. The T-72M1 was designed to be proof against the improved 105mm threats of the early 1980s, such as the Israeli 105mm M111 APFSDS with a tungsten-carbide penetrator, or its American equivalents such as the M735, M735A and M774. Data is also presented here for the T-72B1; this was not in Iraqi service but the data provides an idea of improved protective levels for newer generations of Soviet tanks, intended to counter the newer generation of NATO 120mm tank guns and improved anti-tank missiles such as TOW-2.

There is no unclassified data on M1A1 protective levels from US official sources. The data below for the M1A1 is based on Soviet estimates. No data has been released on the amount of additional protection offered by the M1A1 Heavy Armor upgrade, so the data here should be regarded as estimated.

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Comparative Protective Levels				
(mm RHA)	Hull vs. APFSDS	Hull vs. HEAT	Turret vs. APFSDS	Turret vs. HEAT
T-72	335	450	380	410
T-72M	335	450	380	410
T-72M1	400	490	380	490
T-72B1	530	900	520	950
M1A1	600	700	600	700
M1A1HA	600	700	800	1,300

As is evident from the table, the protective level of the best Iraqi T-72, the T-72M1, was inadequate to provide protection against the 120mm gun of the M1A1 at normal battle ranges. Conversely, the armor of both the M1A1 and M1A1HA could provide adequate frontal protection against the 125mm gun of the T-72M1 – especially when the gun employed the most commonly available tank ammunition, the 3UBM7 round with BM15 penetrator. Both tanks could defeat each other in side or rear engagements.

The tanks differed significantly in internal layout, which affected survivability if penetrated. The T-72 had 22 of its 44 rounds of main gun ammunition in a two-tier carousel under the turret floor, which fed the autoloader; the rest was stowed in various locations around the fighting compartment. The location of so much ammunition in such a confined space was an invitation to catastrophe should the T-72 be penetrated. The T-72 had a greater tendency to "lose its cap" compared to earlier types such as the

This overhead view of one of the M1A1 prototypes at Aberdeen Proving Ground in the United States shows the distinctive rectangular blast panels on the rear of the turret roof that are designed to vent away a fire or explosion should the tank's ammunition ignite. (US Army)

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One of the more curious innovations on many Iraqi RGFC T-72s was a missile jammer, the cylindrical device on the far right in this photograph. This device emitted an infrared beam that was intended to confuse the fire-control of standard NATO anti-tank missiles such as the Milan and TOW, as used by the coalition in the 1991 war. The US modified the TOW guidance system before the war to counter this. (Author)

T-55, due to the increased volume of propellant carried inside the fighting compartment. A fully loaded T-72 carried double the propellant of the T-55 – 440kg compared to 220kg. The T-62 was inbetween at around 310kg.

The M1A1 had 34 of its 40 rounds of main gun ammunition in a protected bustle in the rear turret overhang and the remainder in protected ready racks inside the turret. The aim of this configuration was to minimize the risk of the ammunition being struck by hypersonic debris if the turret was penetrated, and if the ammunition racks were ignited, to vent the blast upwards through special blast panels in the roof rather than forward into the fighting compartment. This was intended to prevent catastrophic destruction of the tank and to give the crew more time to escape. The combination of better armor and better ammunition protection gave the M1A1 a clear protection advantage over the T-72M1.

FIREPOWER

T-72

The T-72 was armed with the 125mm D-81TM (2A46) gun, an improved version of the D-81T (2A26) 125mm gun that went into service on the T-64A in 1968. This was a conventional smoothbore gun with a life expectancy of 600 rounds of HE/HEAT ammunition or 150 rounds of APFSDS, although export customers complained that the actual useful life was closer to 100 rounds of APFSDS. Barrel life was a significant issue for Iraqi tanks as a large proportion of the inventory had been employed during the Iran–Iraq War and the Iraqi army was not especially diligent about keeping its equipment in prime condition; accuracy suffered due to tube erosion.

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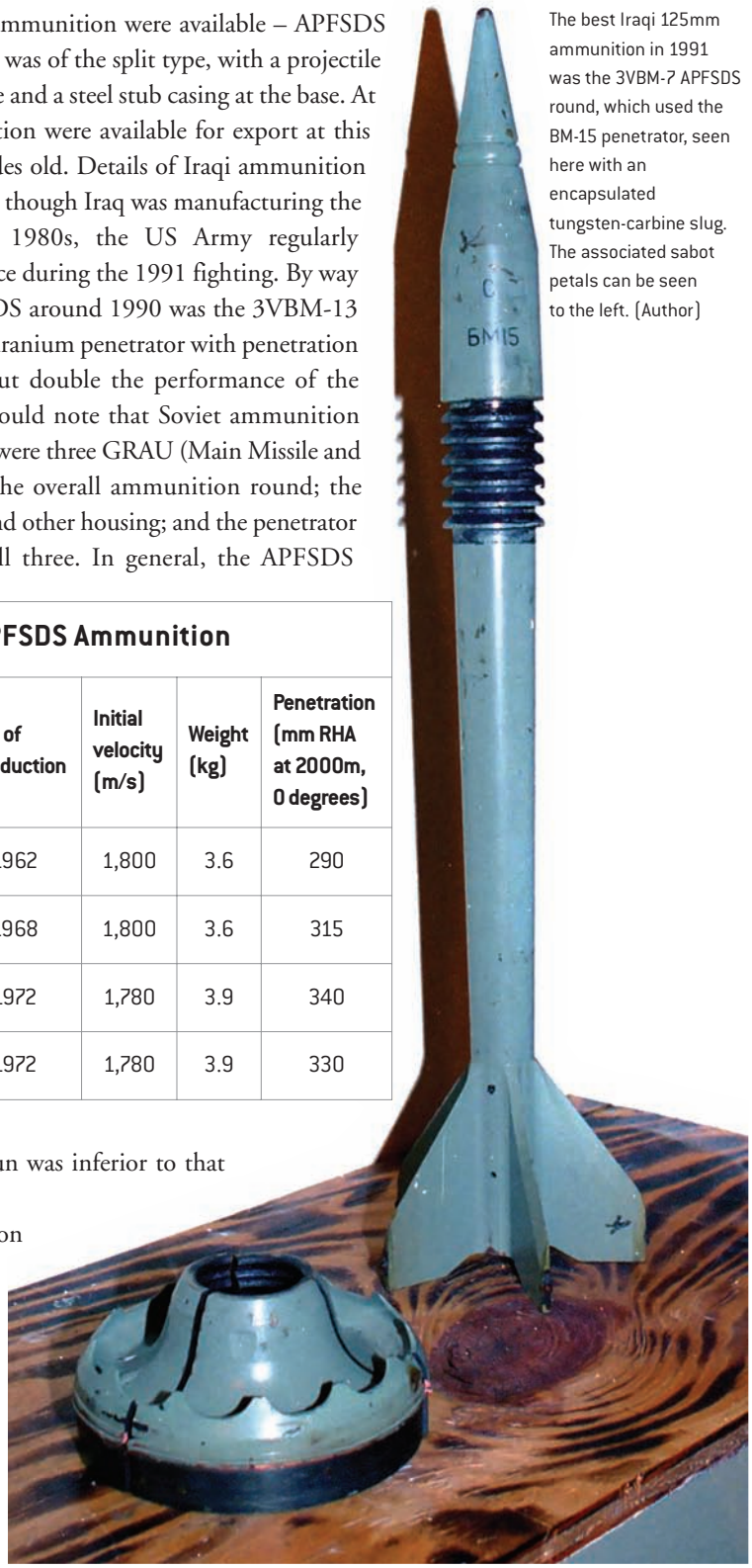
The usual two types of anti-tank ammunition were available – APFSDS and HEAT. The 125mm ammunition was of the split type, with a projectile and a semi-consumable propellant case and a steel stub casing at the base. At least four types of APFSDS ammunition were available for export at this time, most of them already two decades old. Details of Iraqi ammunition stocks are not available; however, even though Iraq was manufacturing the 3VBM-7 ammunition in the late 1980s, the US Army regularly encountered the old 3VBM-3 ordnance during the 1991 fighting. By way of comparison, the best Soviet APFSDS around 1990 was the 3VBM-13 *Vant*, which had a 3BM-32 depleted-uranium penetrator with penetration capability of 560mm at 2km – about double the performance of the 3VBM-3 used by the Iraqis. One should note that Soviet ammunition designations are confusing since there were three GRAU (Main Missile and Artillery Directorate) designations: the overall ammunition round; the projectile, including the sabot petals and other housing; and the penetrator arrow itself. The table below lists all three. In general, the APFSDS performance of the Soviet 125mm gun was inferior to that of the US 120mm gun.

Soviet 125mm APFSDS Ammunition

Round	Projectile	Penetrator	Date of introduction	Initial velocity (m/s)	Weight (kg)	Penetration (mm RHA at 2000m, 0 degrees)
3VBM-3	3BM-10	3BM-9	1962	1,800	3.6	290
3VBM-6	3BM-13	3BM-12	1968	1,800	3.6	315
3VBM-7	3BM-16	3BM-15	1972	1,780	3.9	340
3VBM-8	3BM-18	3BM-17	1972	1,780	3.9	330

Two types of HEAT ammunition were available for export prior to Operation *Desert Storm*: 3VBK-7 and 3VBK-10. These employed conventional finned projectiles with copper liners for the shaped-charge warhead. Penetration capability for the 3BK-14M (3VBK-10) was about 500mm; neither type was capable of penetrating the M1A1 frontally.



The best Iraqi 125mm ammunition in 1991 was the 3VBM-7 APFSDS round, which used the BM-15 penetrator, seen here with an encapsulated tungsten-carbine slug. The associated sabot petals can be seen to the left. (Author)

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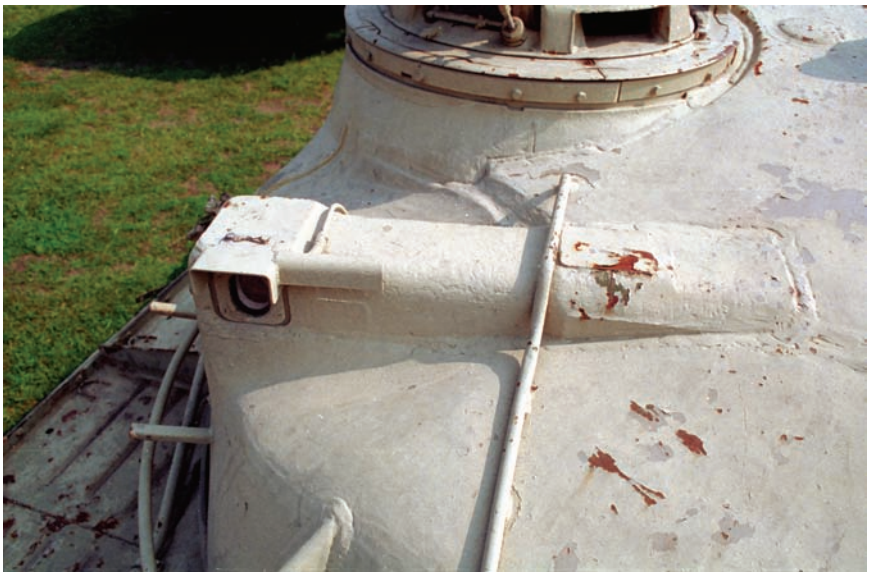

The earliest version of the T-72 in Iraqi service was the T-72 Model 1975, which was still fitted with the TPD-2-49 coincidence rangefinder instead of the laser rangefinder found on the later T-72M and T-72M1. This version can be most easily distinguished by the right-side optical port for the rangefinder that is located in front of the commander's cupola. Optical rangefinders date back to the late 1940s and are not as precise or as simple to use as laser rangefinders. (Author)

The 125mm gun was fed by a mechanical autoloader from the rotating ammunition carousel under the turret basket. The carousel contained an assortment of 22 projectiles and 22 Zh40 propellant cases, stowed horizontally with the projectiles forming the bottom layer and the propellant cases the top layer. The additional rounds were stored in the hull around the turret: four projectiles and propellant cases in pockets in the right front fuel cells, two projectiles and Zh40 cases behind the commander's seat, two projectiles and one Zh40 case immediately behind the gunner, three projectiles on racks on the left rear hull side, six projectiles on the rear firewall, and eight Zh40 propellant cases in cavities in the rear fuel tank, on the floor behind the ammunition carousel. The only ammunition stowage above the turret line comprised five propellant charges near the gunner's and commander's stations.

The gunner sat on the left-hand side and the commander on the right-hand side of the gun. In the T-72M1 the gunner's sights comprised a TPN-1-49-23 active infrared nightsight on the left and the primary TPD-K1 daysight with integral laser rangefinder immediately in front of him. The TPD-K1 offered 8-power while the nightsight offered 5-power magnification. Turret traverse was controlled using a set of handgrips under the TPD-K1 sight, with manual backup provided in case the electric drive was turned off or disabled. To engage a target, on instruction from the tank commander the gunner would first select the proper ammunition type, which set the autoloader in motion. The gunner would meanwhile aim the main TPD-K1 sight at the target and fire the laser rangefinder using a finger control. The range was displayed in the sight, and had to be manually entered into the tank's mechanical ballistic computer. The computer also required manual input of ballistic and meteorological corrections calculated from data available to the gunner before the engagement (degree of barrel wear, charge temperature, barometric pressure and ambient temperature). The only automatic data input was for vehicle movement, and the T-72M1 fire-control system did not incorporate corrections for crosswind data. Although the

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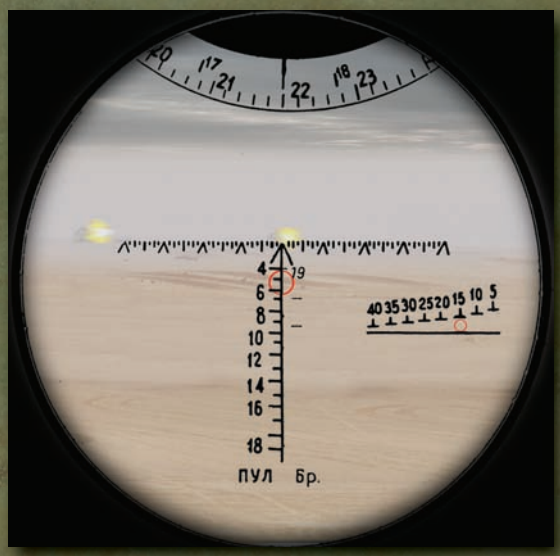
T-72M1 GUNSIGHT VIEW

T-72 gunner's sight, clear conditions



T-72 gunner's sight, foggy/dusty conditions

The T-72M1 gunner's reticle was considerably more cluttered than the comparable M1A1 gunner's sight, since it was a generation older in configuration and relied on more extensive manual inputs from the gunner. The T-72M1 had two reticles – the primary sight for the TPD-K1 daysight and laser-rangefinder as seen, and the TPN-1-49-23 active infrared nightsight. The gunner began by inputting the ammunition type which switched the sight reticle to the proper type – in this case, APFSDS (indicated by Cyrillic letters that transliterate as "Br" on the lower right sight of the vertical gradation; the Cyrillic letters that transliterate as "PUL" indicate "machine-gun"). With this data incorporated, the gunner then placed the red laser aiming circle over the target, using the center one for the main gun or the one on the right of the range scale for the co-axial machine-gun. After firing the laser rangefinder at the target, the gunner read the digital result off the reticle and entered it into the system; the reading appeared on the semicircular dial at the top of the reticle, with the top gradations for the co-axial machine gun and the primary gradations at the bottom of the circle for the main gun; "22" indicates a range to target of 2,200m. If firing on a moving target, the gunner had to place the red laser circle over the target for a few seconds while tracking the target, which entered data about the amount of lead required. Once the range was entered, the gunner then had to place the target above the main aiming mark, the inverted "V" at the center of the main set of gradations, as shown here. This process was so complex, especially under the stress of combat, that Iraqi tankers were often instructed to "battle-sight" their guns, which meant entering a default set of range and ammunition data so that the gunner had only to place the aiming mark on target and fire. The default solution was usually APFSDS ammunition at a range of 1,800m. This may have been a major reason for the poor Iraqi shooting during Operation *Desert Storm*, since US tanks typically began engaging from ranges beyond 1,800m, and Soviet-made APFSDS ammunition was much more prone to dropping at extended ranges than American APFSDS due to the larger fins.

The main reason for the poor Iraqi gunnery during Operation *Desert Storm* is better illustrated by the second sight image, which depicts an engagement such as that at Medina Ridge. The overcast weather, rain, dust clouds and other conditions essentially made the US Army M1A1 tanks invisible to the Iraqi gunners through their sights. The only aiming points were occasional flashes from the Abrams' 120mm main guns. Even if the Iraqi gunner was well trained and attempted to use the laser rangefinder in the prescribed manner, the rangefinder was apt to provide false returns due to the rain and fog. This left the Iraqi gunners to try to aim at the flashes without proper range data, and if their guns were battle-sighted at the usual 1,800m the APFSDS round would fall considerably short.

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autoloader theoretically allowed a maximum rate of fire of eight rounds per minute, in practice the rate was likely to be more limited due to the time required to carry out the fire-control sequence. With limited training, Iraqi T-72 crews would often battle-sight the gun to a pre-determined range, usually 1,800m, and leave these settings in place. The night-vision system for the gunner was active infra-red using the Luna-2AGM turret searchlight and had an effective nighttime range of 800m; the tank commander's TKN-3 daysight/nightsight also had an infrared channel and the commander was provided with a small OU-3GK searchlight for independent illumination which provided coverage to about 400m.

The 125mm gun in the T-72M1 used a 2E28M electro-hydraulic stabilizer. This fire-control system performed similarly to those used in the early-1970s generation of Western tanks, such as the M60A1 RISE, Leopard 1A3, Chieftain Mk 5 or AMX-30. The system was poorly suited to firing on the move due to the complexities of manual data input and the inherent limitations of the gun stabilization system. Firing on the move in the T-72 was only accurate on level ground, at moderate speeds (up to 25km/h) and against a target with small lead angles. The gunner's station was not well designed for firing on the move, with little thought given to providing large brow-pads or a chest rest to permit stability during high-mobility action. Because of these limitations and poor crew training, Iraqi T-72 tanks normally fired from a stationary position.

M1A1

The M1A1 Abrams was armed with the M256 120mm gun, a license-built derivative of the German Rheinmetall gun used in the Leopard 2 tank. By the time of Operation *Desert Storm*, the preferred ammunition for tank fighting was the M829A1 APFSDS round, popularly called the "silver bullet" for its outstanding anti-armor penetration. In contrast to Iraqi tank ammunition, which relied on steel penetrators or steel with a tungsten-carbide insert, the M829A1 used a solid depleted-uranium rod. Depleted

A remarkable photograph of an APFSDS projectile in flight, with the aluminum sabot petals peeling away from the long-rod penetrator. The sabot holds the small-diameter penetrator centered in the gun tube during firing, and is the source of the US Army's nickname for this type of ammunition – "supersabot." (Alliant TechSystems)

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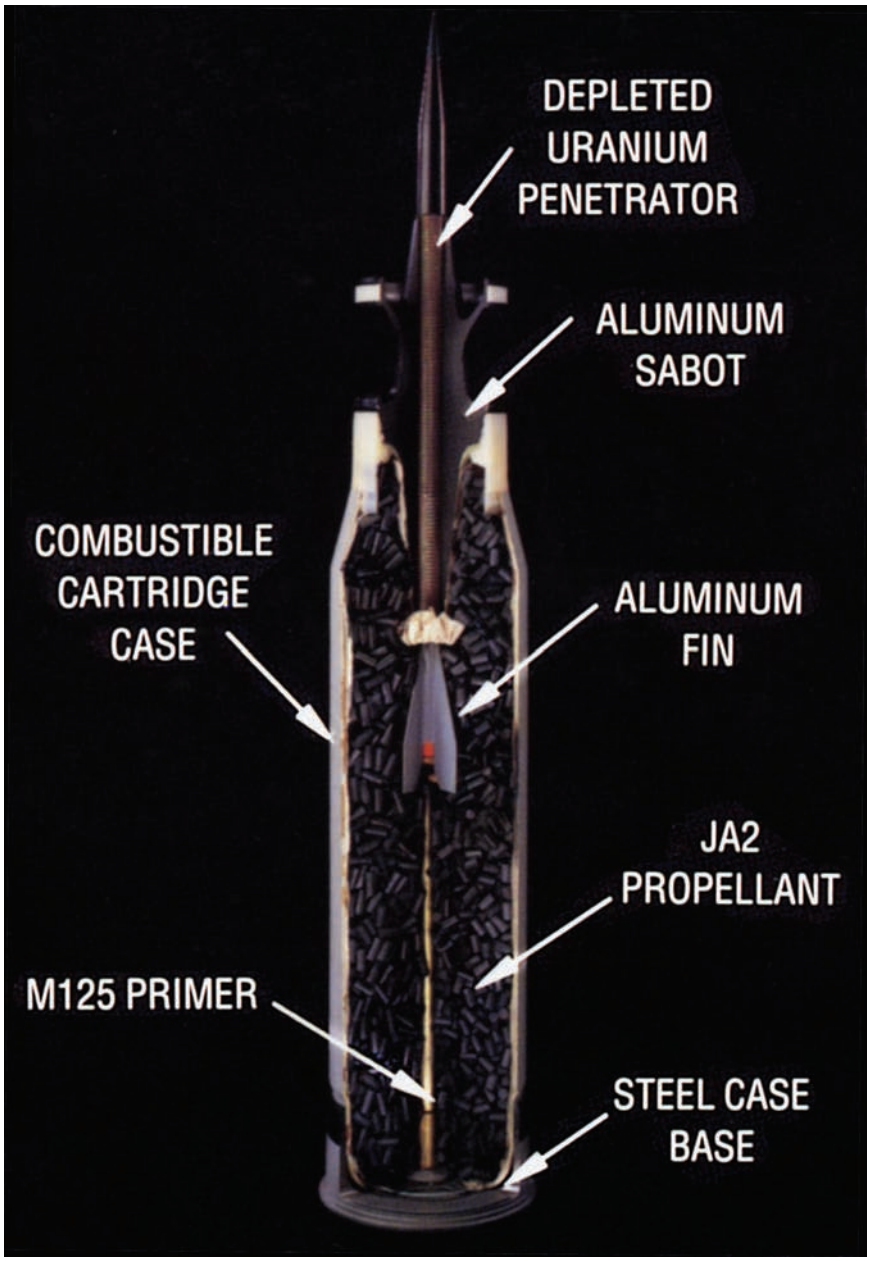

This cutaway of a 120mm M829 APFSDS projectile shows the basic components. Due to the use of a single-piece round, the penetrator could be longer than those used in Soviet two-piece 125mm ammunition. (Olin Ordnance)

uranium (DU) was used in APFSDS penetrators due to its extreme density as well as its unique properties when impacting armor at high velocities. DU has a density of 18.6g/cm^3 compared to only 7.8g/cm^3 for steel. Heavy metal penetrators with comparable densities to DU, such as the traditional favorite, tungsten carbide, exhibit less armor penetration than DU due to differences in effect under the extreme pressure of impact. When a tungsten-carbide penetrator tip hits armor plate it deforms into a broad mushroom shape, much like other metals such as lead, making a wider crater and expending a relatively high amount of energy. In contrast, DU penetrators

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The effect of APFSDS ammunition can be seen on this burnt-out Iraqi T-72 Model 1975; the impact point was circled with a chalk mark by a US evaluation team inspecting tank wrecks after the fighting. (US DoD)

undergo adiabatic shear: during penetration small fragments flake off the tip, leaving a chisel tip which creates a narrow crater, making better use of the energy. The second reason for preferring DU over tungsten carbide was its pyrophoric effects: the high-velocity impact of DU against steel creates small incandescent particles, creating a secondary incendiary effect after penetration which increases internal damage to the enemy tank. Although official figures are lacking, published estimates of M829A1 penetration capabilities are 670mm at point-blank range, 620mm at 1,000m, 570mm at 2,000m and 460mm at 4,000m. In other words, the M829A1 round was capable of penetrating the T-72M1 at normal battle ranges from any angle.

The much superior penetration capabilities of the M829A1 compared to Soviet 125mm ammunition were due to a variety of factors. The NATO 120mm gun offered higher chamber pressures than the Soviet 125mm gun: 5,650 bar versus 4,600 bar which provides some indication of the amount of energy exerted on the projectile. The Soviet use of split ammunition also limited the length of the penetrator dart. Although the Soviet 125mm gun had a higher muzzle velocity, the short penetrator length required wider fins that led to a more rapid loss of speed at longer ranges compared to the long-rod penetrator of the US projectile.

The performance of the M829 and M829A1 rounds during Operation *Desert Storm* surprised the Abrams crews. During peacetime firing, such rounds were not used; instead, training rounds with ballistic safety cones fitted to stop the rounds going too far were used; this in turn degraded the training rounds' ballistic performance and required a different ballistic solution in the tank's fire-control due to the high arch of their trajectory. Capt Mark Gerges commented about experience with combat loads during the fighting:

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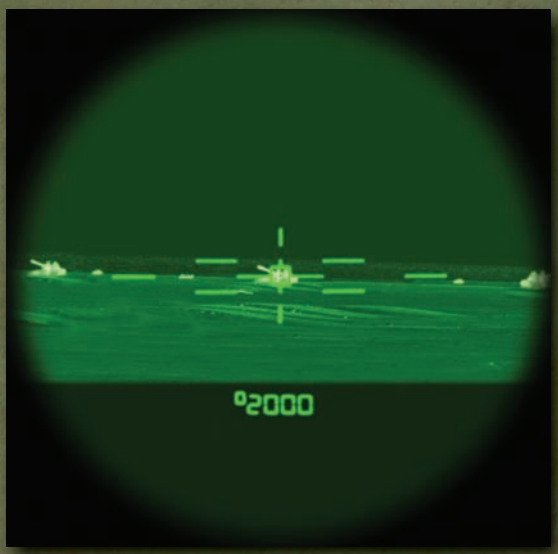
M1A1 GUNSIGHT VIEW

M1A1 gunner's sight, daylight channel



M1A1 gunner's sight, thermal imaging channel

The M1A1 gunner's primary sight (GPS) had both an optical daylight channel and a thermal-imaging channel which could be used day and night. Like the T-72M1 gunner, the Abrams gunner began the process by manually entering the ammunition type. The reticle in the center of the sight consisted of an aiming box one milliradian (mil) in size, equivalent to a target one yard wide at 1,000yd; the aiming mark totals 20mil across. The gunner squeezed the laser trigger, which provided a range in the green digital display below – in this case, 2,000m. Unlike the T-72M1, this data was automatically entered into the ballistic computer and the system made the appropriate gun elevation corrections. The small rectangle to the upper left of the laser range read-out is a "ready-to-fire" symbol. An "F" symbol appeared on the opposite side in the event of a system malfunction. The line above the laser readout indicated multiple laser returns, which would be unlikely in this case and more commonly arose when attempting to determine range through trees or other obstructions.

One of the Abrams' main advantages during much of the *Desert Storm* fighting was the thermal imaging channel in the GPS, which sensed temperature differences between the objects being viewed. In this case the system is set at "white-hit," meaning that warmer objects appear as bright spots and cooler objects appear darker. Even in cases where light fog or rain might obscure the targets – as occurred at Medina Ridge – the thermal sight permitted the gunner to locate targets. The system did have its limitations, particularly at ranges much beyond 2,000m, as the targets then appeared as little more than glowing blobs, making it very difficult for the gunner to differentiate between friend and foe, or between tanks and BMPs.

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At ranges out to 3,600, or even 4,000, there was no observable ballistic solution to the round – it was flat. The kick from the service ammo was also a surprise, and more violent than the not-so-gentle rock we were used to with training ammo. The tanks carried two types of sabot, a load of M829 and seven rounds of M829A1, which we called "supersabot." The plan was to use up the M829 on targets getting to the decisive showdown with the Republican Guards, and then shift to the supersabot because we thought the greater armor on the T-72M1s would need the better round to penetrate. Not quite. We fired only one or two supersabots in my entire company during the fighting.

The M1A1 used an integrated gun/turret stabilization system with line-of-sight stabilization in elevation and gun/turret stabilization in azimuth with hydraulic power for the gun and the turret. The gunner's station was designed from the outset to permit fire-on-the-move operations. For example, the gunner was provided with a large brow-pad to keep his face comfortably away from the sight aperture and other obstacles. The gunner was also provided with a chest rest so that during jarring tank motion he could wedge himself into a firm operating position between the seat-back and fire controls. The fire-control system was designed to minimize the need for numerous data inputs, which instead were handled automatically; the laser rangefinder was integrated into the gunner's primary sight. The fire-control system utilized a digital ballistic computer designed to be operated with minimal training, using automatic data inputs to improve overall gun accuracy with minimum attention from the gunner. It would automatically input data from wind and cant sensors, as well as data on tracking rates for lead corrections based on the turret traverse. The gunner would manually enter other data, such as air temperature, ammunition temperature, barometric pressure and tube wear, but this

Fire-control innovations gave the M1A1 Abrams still greater accuracy. The device at the end of the gun barrel is the Muzzle Reference System – an optical sensor that links to the fire-control computer to indicate the amount of barrel warp induced by thermal heating and other factors. The data is then automatically entered into the digital ballistic computer to determine the necessary aiming corrections. (GDLS)

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could be done prior to the engagement to minimize the need for attention during combat. The gunner's primary sight was configured for both a 3-power wide field of view for surveillance and target acquisition, and a 10-power narrow field of view for aiming.

The most substantial difference between the fire-control systems for the M1A1 Abrams and the T-72M1 was the provision in the M1A1 of an integrated thermal imaging subsystem (TIS) two generations more advanced than the T-72M1's active infrared system. Active infrared systems required infrared searchlights for nighttime illumination, which made any tank using such a system glaringly evident to enemy tanks. Most major NATO armies shifted from active infrared to image-intensification night-vision systems in the late 1970s. Image-intensification sights were passive, without the need for dangerous searchlights; they relied on ambient moonlight or other sources for illumination. These electro-optical sights collected the small amounts of light available even with partial moonlight, and amplified them sufficiently for the gunner to be able to acquire and engage targets. Their main disadvantage was that they

Above: The thermal imaging system provided the M1A1 Abrams with a critical technological edge during *Desert Storm*. Manufactured by Hughes Aircraft Company (now part of Raytheon), these sights were quite expensive – accounting for about ten percent of the cost of the entire tank. (Hughes)

Left: The M1A1 gunner's primary sight (GPS) contains a thermal imaging system, and an optical extension is visible at the top of this picture which allows the commander to see the same image. Note that the commander (to the right) has his own hand-control which allows him to slew the turret in the direction of the target. (GDLS)

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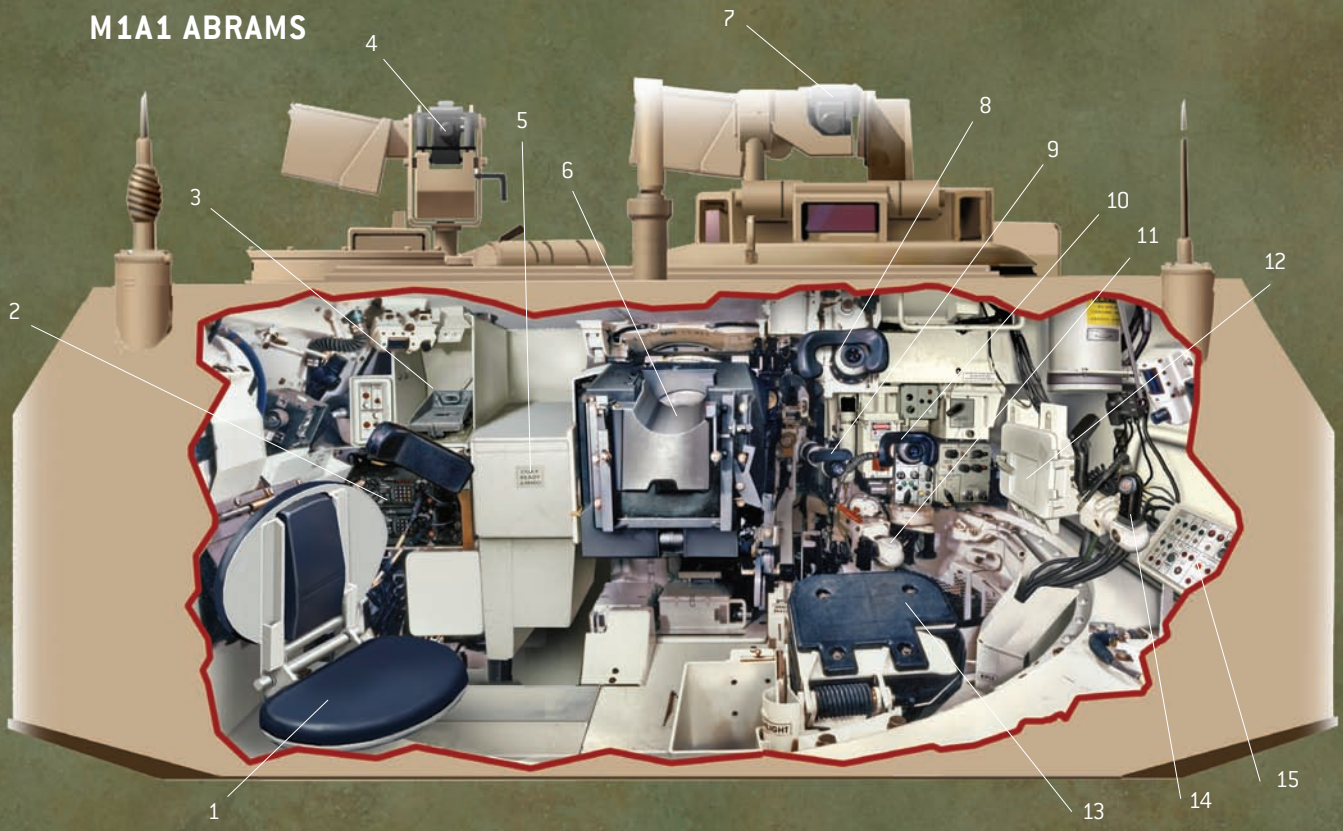
M1A1 ABRAMS



KEY

1. Loader's seat
2. Tank radio
3. Machine gun ammunition compartment
4. Loader's M240 machine gun
5. Co-axial machine gun ammunition stowage
6. M256 120mm gun breech
7. Commander's M2 heavy machine gun.
8. Commander's sight
9. Gunner's auxiliary (telescopic) sight
10. Gunner's primary sight
11. Gunner's controls
12. Fire control computer panel
13. Gunner's seat (back rest folded down)
14. Commander's handles
15. Commander's control panel

US 120MM AMMUNITION

The M829A1 120mm APFSDS-T (armor-piercing, fin-stabilized, discarding-sabot, with tracer) was the premier US tank-fighting ammunition of Operation *Desert Storm*, variously nicknamed the "silver bullet" or "supersabot." In tanker's parlance, this type of ammunition is nicknamed "sabot," a contraction for the otherwise excessive full designation of the ammunition. Sabot, from the French word for a wooden shoe, refers to the light metal jacket around the penetrator dart that keeps it in place in the gun tube during the firing process and which peels away after the round leaves the gun tube. The M829A1 used a "long-rod" penetrator with a high length/diameter ratio, meaning that the dart was especially long compared to the diameter of the rod. The penetrator itself was machined out of depleted uranium, which offers both high mass and excellent penetrating qualities.

The M830 120mm HEAT-MP-T (high-explosive anti-tank multi-purpose with tracer) was the other combat round regularly used by US tanks in Operation *Desert Storm*. By this time, the APFSDS was the preferred tank fighting round, but it was not ideal for use against light armored vehicles since it was so powerful it tended to pass completely through the enemy vehicle. HEAT ammunition was the preferred type when dealing with light armored vehicles since the shaped-charge, high explosive warhead could easily penetrate any armored vehicle, and the "behind armor" effect of the warhead was very substantial, causing a tremendous amount of internal damage to the enemy vehicle. The HEAT round was considered a "multi-purpose" round in the US Army since at the time, a dedicated high-explosive fragmentation (HE-Frag) round was not on hand for the 120mm gun; the T-72 had both a HEAT and an HE-Frag round. HE-Frag ammunition is traditionally used against "soft," that is non-armored targets such as trucks, emplacements and buildings. Lacking a dedicated HE-Frag round, the HEAT round was used in its place when engaging these targets.

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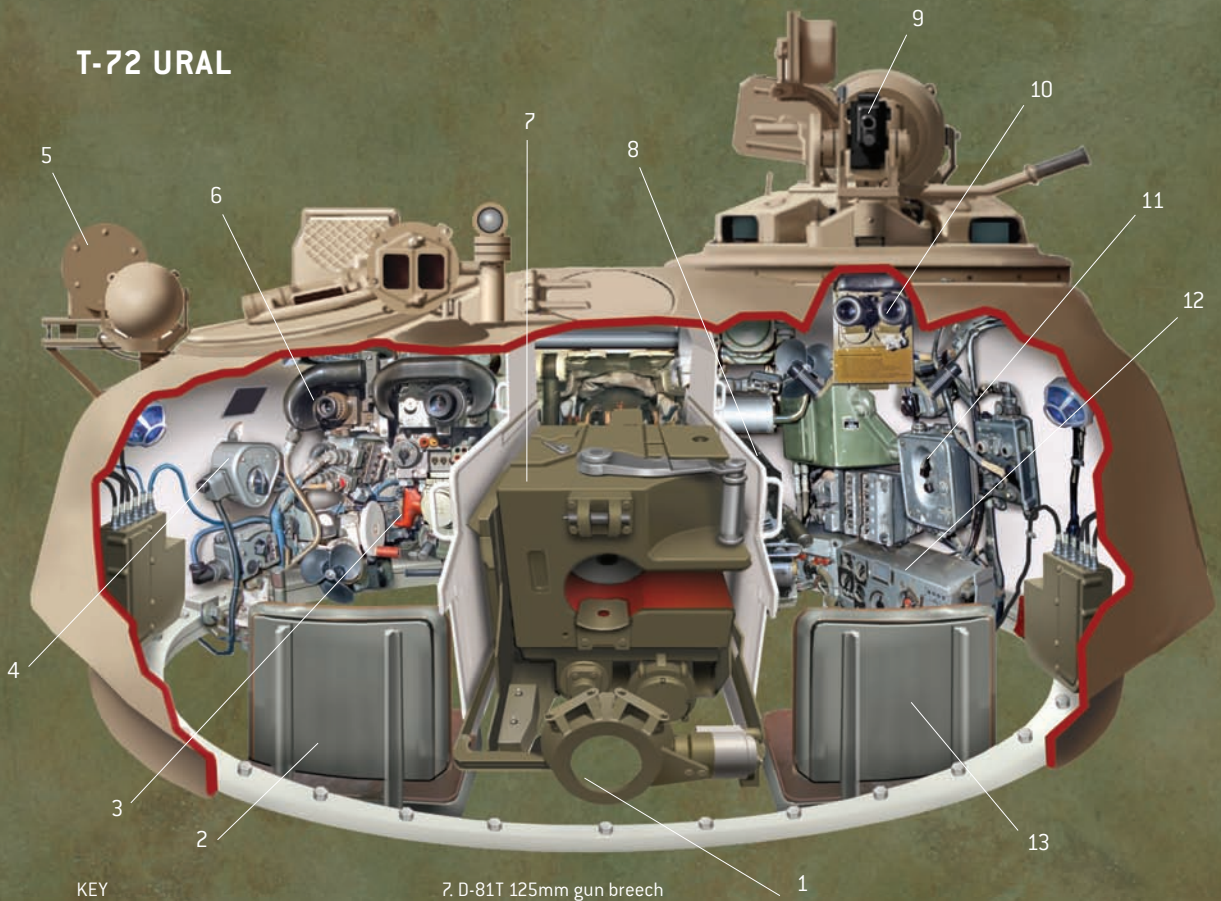
T-72 URAL



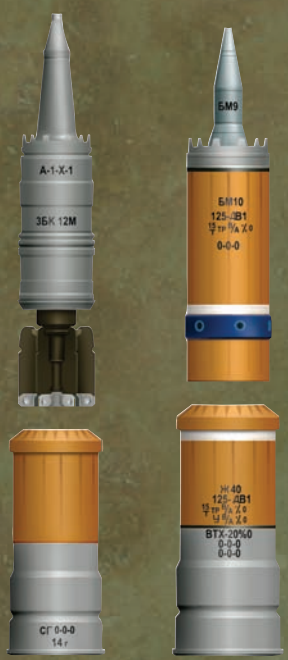
KEY

1. Autoloader rammer
2. Gunner's seat
3. Gunner's controls
4. Gunner's intercom switch
5. Electro-optical missile jammer
6. Gunner's TPN-1-49-23 infrared sight
7. D-81T 125mm gun breech
8. Co-axial machine gun
9. Commander's 12.7mm machine gun
10. Commander's cupola sight
11. Commander's intercom/radio switch
12. Tank radio
13. Commander's seat

IRAQI AMMUNITION

The 3VBK-10 125mm HEAT round consisted of a 3BK12M projectile and a consumable propellant case. The illustration here shows the two-piece ammunition as it would be stowed in the tank. After the 3BK12M projectile was fired, the fins at the rear of the projectile would pop out to help stabilize the round in flight. The long probe at the front of the projectile contains the fuze to detonate the shaped charge. It is placed as far in front of the explosive as possible to detonate it in time and to establish an optimum stand-off range between the shaped charge and the target. Shaped charges are generally more effective when detonated at a distance away from the target since this stand-off distance permits the hypersonic stream created by the shaped charge to form properly and maximize its penetrating power. The propellant case consisted of a metal stub casing at the bottom of the case plus a synthetic liner to contain the propellant charge; this liner would be consumed when the gun fired, leaning only the stub case.

The 3VBM-3 125mm APFSDS round was the oldest type of 125mm ammunition still in Iraqi service during the 1991 war. It consisted of a BM9 steel penetrator, a BM10 projectile, and a Zh40 consumable propellant case. The use of split, two-piece ammunition in the T-72 limited the potential length of the penetrator dart so it suffered from a shorter length/diameter ratio than the penetrator in US ammunition which degraded its performance. In addition, the penetrator dart was made of steel which had markedly poorer penetration than heavy metals such as tungsten carbide or depleted uranium. The Iraqi T-72 tanks also used the improved 3VBM-7 round which used a BM15 tungsten carbide penetrator. As can be seen in the illustration here, the BM10 projectile contained both the BM9 penetrator and an additional increment of propellant to increase the speed of the projectile.



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The tremendous power of the Abrams' gas-turbine engine prompted the army to have an engine governor installed which limits its speed to about 45mph. Although the tank is capable of speeds of more than 60mph, there were concerns that excessive cross-country speed could injure the crew and damage vehicle components. (US DoD)

needed some form of natural illumination, at least one-quarter moonlight, and this might not be available on totally moonless or cloudy nights. The next generation of sights, thermal imaging or FLIR (forward-looking infrared) sights, got around the limitations of the image-intensification sights by sensing minute differences in reflected or ambient infrared energy. Tanks moving at night have a very distinctive infrared signature since their engines give off thermal energy, as do their wheels and tracks. Even stationary tanks have a distinct signature since they collect solar heat during the day, which disperses at night. The thermal sights have a secondary function in daytime, since they have some capability to peer through atmospheric phenomena such as smoke, mist, and fog that would be opaque to normal human vision. Thermal sights were first used on the US Army's M60A3 (TTS) tanks. The TIS on the M1A1 was better integrated than the T-72M1 gunner's nightsight, which used a reticle separate from the gunner's normal fire controls. The M1A1 had an auxiliary sight – a conventional telescopic sight – for use in the event of failure of the primary equipment; the T-72M1 lacked a spare sight.

In terms of firepower, the M1A1 outclassed the T-72M1 in all respects: it had better ammunition, better penetration, better performance at longer ranges, more sophisticated fire controls, better fire-on-the-move capability, and better crew ergonomics. But regardless of the technical details, the bottom line was that the 125mm gun and the ammunition available to the Iraqis could not frontally penetrate the M1A1 tank, while the M1A1's 120mm gun could penetrate the frontal armor of the T-72M1 at typical combat ranges.

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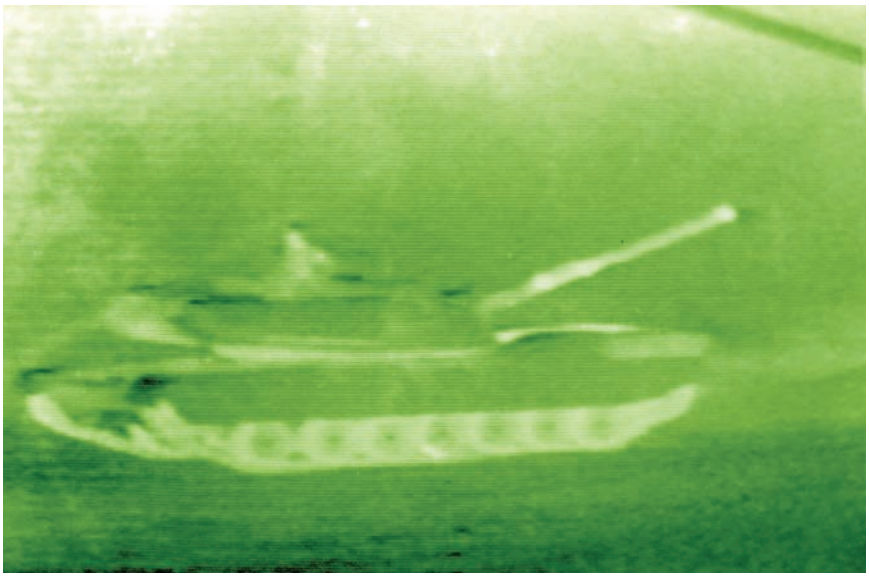

The thermal-sight image differs from conventional optical images in that warmer areas show up with greater intensity than cooler areas. This image of an M1 tank in motion shows the wheels and tracks as relatively hot due to friction. The gun barrel and engine deck are also more visible. (US Army)

MOBILITY

The M1A1 Abrams was powered by an AVCO-Lycoming AGT-1500 gas-turbine engine. This offered 1,500hp or about 23hp/t. Turbines provide more power for a lighter weight than did comparable diesels of the time, and offered superior sustained high-speed travel; their main drawback was higher fuel consumption. During typical peacetime training exercises, US tankers found that the M1A1 Abrams could operate for about a day on a single load of fuel compared to about three days for the earlier M60A3 tank. The M1A1 had a notional road range of about 290 miles; ideal fuel consumption was 1.8 gallons per mile. The Abrams' actual range was quite variable, and usually lower, because turbine engines consume more fuel at idle than comparable diesel tank engines. Modern tanks do not shut off their engines when static since it is necessary to keep the batteries charged to operate various electrical systems, including the radio and fire-control system. The M1A1 had an hourly fuel consumption of 10.8gal at idle, 44.6gal on the road and 56.6gal cross-country. The main solution to the Abrams' fuel consumption problem was to provide adequate logistical support – an Abrams tank battalion had 16 HEMTT tanker trucks each carrying 2,500gal of fuel.

The T-72M1 was powered by a V-46-6 diesel engine producing 780hp. This gave the T-72M1 a power-to-weight ratio of about 19.8hp/t and a maximum road speed of about 37mph – somewhat less than the M1A1. Internal fuel capacity was 1,000 liters (264gal) and a further 400 liters were typically carried in two external drums. The T-72 had an optimal fuel consumption of one gallon per mile, so even though it only carried about half the internal fuel of the M1A1, its average road range was about the same.

The M1A1 had better mobility than the T-72M1 in terms of actual power per ton as well as better ergonomic design of the crew stations; however, the T-72M1 offered better fuel economy.

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THE COMBATANTS

The most significant difference between the crews of the M1A1 Abrams and the T-72M1 Ural was the lack of a loader in the T-72M1, leaving it with a crew of three versus four in the Abrams. Otherwise, crew functions were very similar. There has been long-standing controversy over the desirability of autoloaders versus human loaders. The US Army has generally favored human loaders for two reasons. Firstly, there is some advantage of a human loader over an autoloader in the first critical moments of a tank battle, since a well-trained crew can get off the first three rounds in around 15 seconds compared to two rounds or fewer from the T-72 autoloader. Secondly, US tankers feel that additional crewmen are vital in day-to-day combat conditions due to the enormous amount of work required for maintaining and resupplying the tank, as well as providing security when at rest. In the Soviet view, using an autoloader saved a considerable amount of internal volume in the design, permitting a smaller turret and a smaller, lighter tank. Also, an autoloader permits a faster sustained rate of fire – about eight rounds per minute in the T-72M1 compared to about four rounds per minute for the M1A1 Abrams.

M1A1 TANK CREW

The M1A1 had a crew of four: tank commander (TC), gunner, loader, and driver. All were stationed in the turret except for the driver, who was positioned in the center of the front hull. In the turret the loader was on the left and the gunner and TC were on the right.

The tank commander was positioned behind the gunner and was responsible for leading the tank in combat. In a four-tank platoon, the leader was a second lieutenant

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The commander and gunner sit in the right side of the turret of the M1A1 Abrams, with the enormous breech of the 120mm gun in the center. (GDLS)

(O-1); the platoon sergeant was usually a sergeant first class (E-7) or staff-sergeant (E-6); the two "wingman" tanks would also be commanded by sergeants. The TC was stationed below a rotating cupola and hatch that provided all-round direct vision, when "buttoned up," by means of periscopes. The TC was also provided with an optical adjunct from the gunner's primary sight and the commander could aim the tank's weapon and fire it if necessary using these override controls. The TC's hatch had three positions: fully open, fully closed, and intermediate, in which the overhead hatch could be locked partially open to allow the TC to hear and see all around while offering some overhead cover. US Army training encouraged TCs to ride with their heads outside the tank, since this provided better situational awareness. The commander's station included a .50cal heavy machine-gun on a remote-control mount; this could be operated from inside the tank when fully buttoned-up, and a periscopic sight was provided for this function. The commander also had controls for activating the smoke-grenade launchers on the front sides of the turret, which were used for defense.

Second in seniority in the tank crew was the gunner, a sergeant. The gunner's primary sight (GPS), located immediately in front of him, comprised an integrated day/night sighting system with laser rangefinder and a digital ballistic computer. The M1A1 fire controls were designed to be as automated as possible to permit the gunner to concentrate on his main task of acquiring the target identified by the commander, and accurately aiming the tank's weapons. The gunner's inputs included selecting whether to engage the target with the main gun or the co-axial machine-gun and identifying the main gun ammunition type to ensure the ballistic computer set the

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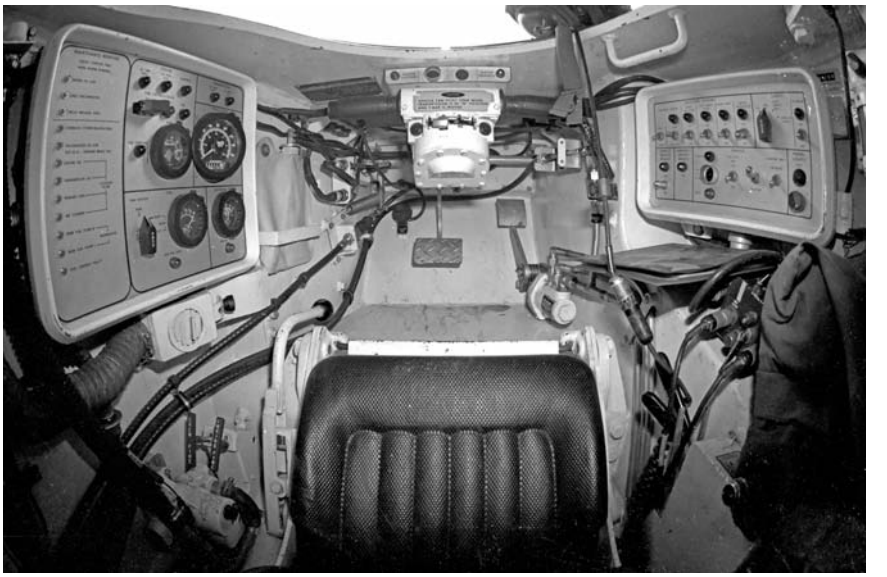

The driver in the M1 Abrams sits in a semi-prone position and steers the tank using a set of yokes resembling motorcycle handlebars, with foot-pedals for acceleration and braking. (Author)

proper offsets. The gunner's controls were operated using palm switches on the "Cadillac" grips which allowed him to turn the turret right or left, elevate or depress the main gun, and trigger the main gun or co-axial machine-gun.

The loader was usually lowest in seniority. He armed the main gun on the instructions of the TC and had to be quite strong and agile as the rounds weighed more than 65lb each. The main ammunition stowage was in the turret bustle behind blast doors, with two 16-round racks on either side and one or two two-round ready racks at the extremities. There was an additional three-round ready rack in front of the loader in the left hull. Access to the main ammunition reserve in the left rear bustle was by means of a blast door actuated by the gunner using a knee switch which let him keep his hands free during the loading process. The loader's hatch was fitted with an M240 7.62mm machine-gun for close-in defense of the tank. The tank radio was located in front of the loader's station.

The crew of tank B-66 following the Medina Ridge battle – from left to right, Sgt Jerry Reynolds (gunner), PFC Bowie (loader) and PFC Eugene Mendoza (driver). (Mark Gerges)

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The driver was isolated from the rest of the crew in the forward hull. The M1A1 driver's station represented a considerable departure from earlier US tank designs. Instead of sitting in a conventional seat, the driver lay on his back in a semi-prone position. However, the seat could be raised to let the driver sit up when operating with his head outside the hatch, or lowered to a more prone position when driving buttoned-up. The driver's main controls took the form of a steering yoke which operated much like motorcycle handlebars.

T-72M1 CREW

The T-72M1 was conventionally laid out, with the driver located centrally in the hull and the commander and gunner on the right and left sides of the turret respectively. Due to the small turret volume and the enormous size of the gun breech the turret was extremely cramped, more reminiscent of World War II tanks than modern main battle tanks.

The tank commander's main sight was the binocular TKN-3 sight, mounted in a fully traversable cupola; unlike the Abrams, the commander did not share the optical imagery with the gunner. The tank commander could override the gunner's controls to traverse the turret, and he could bring the turret to his line of sight with the control handle on the TKN-3. The commander also had several small optical periscopes; however, the view they provided was much more interrupted than that with the M1A1 Abrams. The commander's station included an R-173 tank radio, and the commander's cupola was fitted with an NSVT 12.7mm *Utes* ("Rock") heavy machine gun; however, this was aimed rearward when the commander's main sight was pointed forward and the cupola had to be rotated for the weapon to be used. This gun was designed to be manually operated by the commander from outside the vehicle, not by remote control from inside. One of the peculiarities of Soviet tank design was that the commander's hatch opened forward, blocking the commander's view and discouraging him from riding with his head outside the tank during combat. This represented a fundamentally different design

The T-72M1 commander sits on the right side of the turret. The floor of this Iraqi T-72M1 is still littered with debris after the tank has been brought back to the United States, and the vehicle is missing its radio, which would normally be mounted on the empty rack in the center of the picture. (Author)

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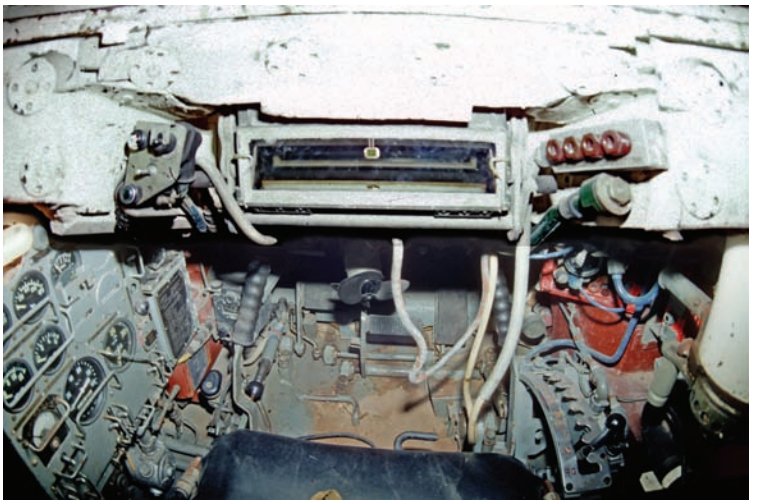

Above right: The driver's station in the T-72M1 has a more traditional layout and controls than the M1A1 and is very cramped. When buttoned up, the driver's sole means of vision is the periscope, prominent at the top of this picture. (Author)

Above left: The gunner sits on the left side of the turret in the T-72M1, with his primary TPD-K1 daysight with laser rangefinder on the right and the auxiliary TPN-1-49-23 active infrared nightsight on the left. (Author)

philosophy to the US approach and offered further evidence of the relatively low priority afforded to ergonomics in Soviet tank design.

The gunner's station was even more cramped than the commander's, due to the bulky sighting system immediately in front of the gunner. The gunner's sights comprised a TPN-1-49-23 active infrared nightsight on the left and the primary TPD-K1 daysight with integral laser rangefinder immediately in front of him. Turret traverse was accomplished using a set of handgrips located under the TPD-K1 sight.

The driver sat centrally in the hull front, with a single large periscope mounted in the glacis plate, and two smaller periscopes mounted in the hatch over his head. The driver's controls were traditional braking levers rather than the steering yokes found in most contemporary Western tanks. These required more skill and strength to operate than the controls in the M1A1. This station was extremely cramped and the driver's controls were not well situated, being located to the side where they were harder to see during operations.

CREW TRAINING

IRAQI TANK CREW TRAINING

There is very little detailed information available about Iraqi tank crew training prior to Operation *Desert Storm*, although a certain amount can be inferred from the combat performance of Iraqi tank units. By the time of the invasion of Kuwait in 1990, the Iraqi army had grown from about six to about 60 divisions and was at the time the fourth largest army in the world. This massive expansion had come at a price, however, and the Iraqi army suffered from problems typical of developing countries – its troops were drawn from diverse cultural backgrounds, and often had poor education and limited technical training.

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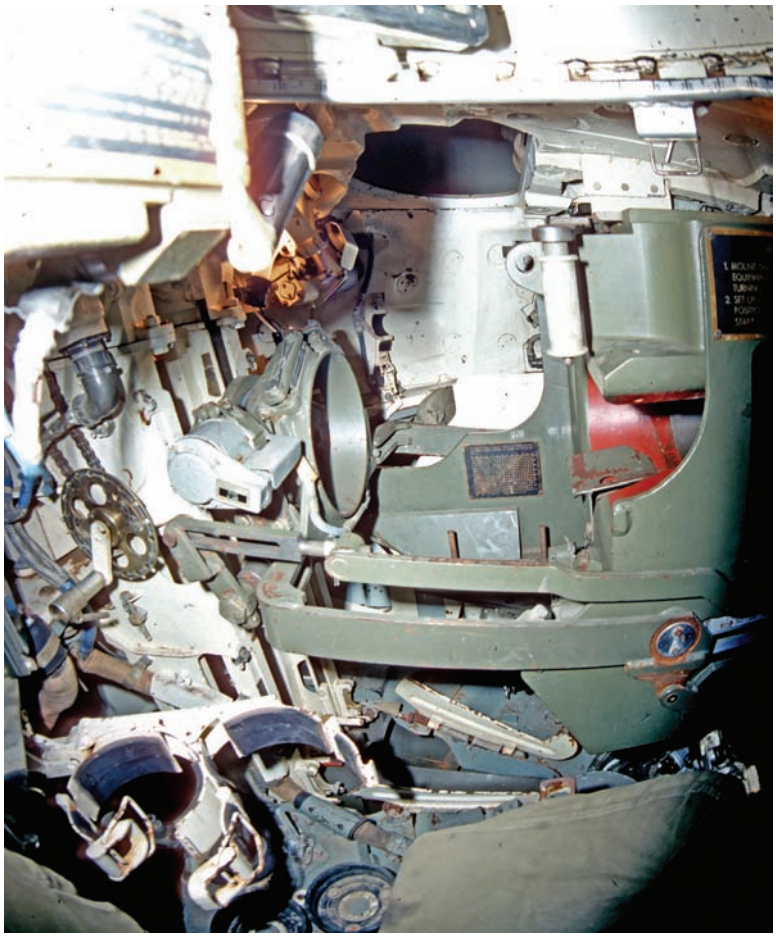
The army's tactical leadership was crippled by the paranoia of Saddam Hussein's Ba'athist regime. Loyalty was brutally enforced by secret police and by periodic officer purges; minor failures or missteps could prove fatal. Army control was heavily centralized and the pervasive fear instilled by the regime encouraged tactical commanders to follow orders strictly and discouraged personal initiative or flexibility. The Iraqi army, as in most developing nations, lacked an experienced and trusted cadre of NCOs, which has always formed the backbone of any technical combat arm such as tank forces. The authoritarian command-and-control tradition proved adequate against the slow-moving and equally inept Iranian army, but such rigidity was poorly suited to a fast-moving war of maneuver of the kind the Iraqi army would have to fight in 1991.



The T-72M1 needed a smaller crew than the M1A1 Abrams due to the use of an autoloader. This is a view of the autoloader from the commander's station with the large circular ramming device behind the breech. (Author)

By the end of the war with Iran, the Iraqi army had a significant body of combat-experienced senior commanders, but further down the tactical ladder the quality of combat leadership tended to weaken. To compensate for the poor quality of most of the army's units, during the 1980s Iraqi commanders had learned to rely on carefully scripted combat operations, with units assigned a series of relatively simple and rehearsed tasks that did not depend on high levels of initiative or skill on the part of the lower tactical formations. Furthermore, the massive expansion of the army between 1980 and 1988 led to further dilution in quality of units, forcing the Iraqi army to rely more and more on a core of elite formations to carry out the most critical and demanding missions. Such units were primarily those of the Republican Guards Forces Command (RGFC) and the better regular army armored divisions.

The Republican Guards (*Al-Haras al-Jamhaori*) had originated as a praetorian guard to defend Saddam Hussein and his Ba'ath party leadership. Hussein favored fellow Sunnis – members of the same sect of Islam – for sensitive security posts, and especially those from his hometown of Tikrit. Loyalty to Saddam and the Ba'ath Party were the primary criteria for serving in the Republican Guards. The poor performance of the Iraqi army in the first years of the Iran–Iraq War led to fundamental changes

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within the Republican Guards during 1986 – it expanded from the Ba'ath Party's elite guard force into a much larger formation of elite combat brigades and divisions. The RGFC armored units were given priority for the latest equipment, so the new T-72 tanks were found primarily in RGFC units. The enlisted men were mainly from the Sunni minority, and had better pay, uniforms and equipment. It is unclear whether training was markedly better than in the rest of the army, but the RGFC troops were certainly far better motivated than the rest of the army, as would become very evident in the 1991 Gulf War.

Although tanks were widely used by both the Iranian and Iraqi armies in the 1980–88 war, in the later years of the conflict tank-versus-tank fighting was very limited due to the small numbers of functional Iranian armor. Iraqi tank units were used primarily to provide fire support for the infantry, and this led to less emphasis on tank fighting skills. The Iraqi army fought a largely defensive war in the late 1980s, with tanks regularly fighting from fixed positions. This did not encourage the development of the kind of tactical skills associated with NATO or Warsaw Pact armies, which assumed that tanks would be used primarily in a mobile role. The widespread Iraqi use of tanks in an infantry support role also led to relatively high usage rates for the main guns. The lack of durability of Soviet gun tubes and the Iraqi propensity to cut corners in maintenance meant that by 1990 a significant proportion of tanks had worn-out gun tubes – limiting their accuracy, particularly if tank gunners were not trained to properly input barrel-wear data into the tank's ballistic computer. These factors may partly account for the abysmal gunnery of Iraqi tanks in the 1991 war. Although US tankers repeatedly saw evidence of Iraqi tanks firing at them, reports of actual hits on US tanks were extremely few. Iraqi tankers were not as well trained in maintenance as US tankers, and repairs that in the US Army would routinely be undertaken within the company or battalion were delegated to specialized maintenance units or even to rear-area repair facilities. The level of training of Iraqi tankers was extremely poor by NATO standards; nevertheless, the Iraqi army was widely regarded as one of the more battle-hardened and combat-capable Arab armies of the time.

The T-72 tank was fitted with a retractable scraper blade under the nose, which could be used as an improvised bulldozer blade. This feature was widely used by the Iraqi army to hastily create defensive positions in the desert when regular engineer equipment was not available. (Author)

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US TANK CREW TRAINING

The US Army had undergone a renaissance in the 1980s after the hollow years of the 1970s. During the Reagan period the army had finally shaken off the legacy of the Vietnam War, and many young officers who had been platoon, company or battalion commanders in Vietnam had become senior leaders by the 1980s and were ardently intent on reform. The intellectual ferment within the officer corps culminated in the "Air-Land Battle" doctrine and greater emphasis on "train as you fight." At the same time, increased defense funding in the 1980s permitted both a rejuvenation of equipment such as the adoption of the M1 Abrams tank and M2 Bradley infantry fighting vehicle – as well as a substantial increase in operations and maintenance funding which permitted more and better-quality training. The shift from the Vietnam War's conscript army to a professional army was an important element in boosting the motivation and skills of the soldiers.

US tanker training has traditionally centered around Fort Knox, Kentucky, home of the Armor School since World War II. After basic training, US army tankers were sent to Ft Knox for specialist training. Young second lieutenants were sent to the Armor Officer Advance Course. The 1980s saw the beginning of a technical revolution in training. In the past, training on maintenance-intensive weapons such as tanks was invariably limited by budget, since training leads to considerable wear and tear on the equipment and the expenditure of costly training ammunition. The advent of the M1 Abrams was accompanied by the advent of computer-based training simulators. These could not substitute for hands-on training with real equipment, but acted as an invaluable supplement to traditional technical-skills training since they allowed new tankers to repeatedly rehearse basic combat skills more often and at a far more modest cost. The computer-based tank simulators at Ft Knox also allowed elementary small-unit training, since the individual "tanks" could be netted together by computer to conduct missions.

Once through their specialist training, tankers were dispatched to their units where training continued, as the US Army fostered a system of ongoing training within the unit. Ft Knox also served as the venue for continued career training, with the Advanced NCO Course and Armor Officer Advanced Course. The growing technical proficiency of US tankers became evident in tangible ways. The NATO armies in Europe had traditionally held a Canadian Army Trophy gunnery contest, and US Army teams had not won the event for nearly two decades until an M1 Abrams team won in 1986. Once crews were assigned to forward-deployed units in Germany, technical skills continued to be honed through training – for example, gunnery skills at the ranges at Grafenwohr and small-unit skills at the Combat Maneuver Training Center at Hohenfels.

Technological innovations helped add to the frequency and realism of small-unit tactical training – as with the introduction of laser simulation devices which made it possible to conduct more realistic tank-on-tank engagements during exercises. The culmination of this revolution in training was the refurbishment of the army's Mojave Desert training center as the National Training Center (NTC). The NTC was

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computerized and fully instrumented to allow the recording of simulated battles, so post-mortems could be conducted and lessons learned. The NTC had its own highly trained "opposing force" (OPFOR) to ensure a constant and demanding test experience for visiting units. Rotation through the NTC encouraged units to practice and prepare in advance of their arrival on the desert battleground, which further polished small-unit tactical skills. Increased funding in the 1980s was instrumental in this process, since rotating a brigade through the NTC cost in the order of $10 million. By 1990 the US Army was arguably the best-trained military in the world.

The tank crew of Capt Mark Gerges, featured in the duel described later, provides a good example of the training of US Army tank crews. Capt Gerges's crew had been together for ten months as part of the 1st Armored Division in Germany. The company had been through a Hohenfels rotation in March–April 1990 and then undergone further tank gunnery training during the summer prior to being alerted for deployment. The crews had performed well at gunnery; Bravo Company was a high-scoring company in 2–70 Armor, gaining 842 out of a possible 1,000 points. The effect was increased confidence in the M1A1's fire-control system.

Capt Gerges was a distinguished military graduate of Norwich University (1984), and after being commissioned in armor he graduated from the Armor Officer Basic Course and the Nuclear, Biological and Chemical Officers' Defense Course. He had served in armor units in Germany and Texas prior to returning to Germany in the winter of 1989, then served on the staff of 2nd Brigade, 1st Armored Division for a year before taking command of Bravo Company, 2–70 Armor, in February 1990, a year before the Battle of Medina Ridge. He was 29 years old at the time of the fighting and was awarded the Bronze Star and Bronze Star with Valor device for his actions in Operation *Desert Storm*.

The advent of laser training simulation devices such as the US Army's MILES system permitted the construction of very realistic force-on-force training centers to test small-unit training, most notably the National Training Center in the Mojave Desert of southern California. Here, an M1 with MILES devices is seen on exercise at the NTC in the autumn of 1990, shortly before Operation *Desert Storm*. (Author)

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THE STRATEGIC SITUATION

On August 2, 1990, the Iraqi army overran Kuwait, spearheaded by T-72 tanks of the Republican Guards. President George H. Bush proclaimed: "This shall not stand," and the United States began mobilizing a coalition to liberate Kuwait. President Saddam Hussein had picked a particularly bad time to provoke the US and its allies as the climax of the Cold War had meant there was a substantial reserve of heavy combat forces in Germany that could quickly be deployed to the Arabian Gulf. The American strategic concern was not simply Kuwait; it was feared that Iraq would use Kuwait as a springboard for launching further troubling attacks in the region, potentially involving seizure of the nearby Saudi oilfields. Saudi Arabia perceived this threat as so serious that it quickly joined the anti-Iraq coalition and pressured other Arab states to do so as well, including Egypt and Syria.

IRAQI STRATEGIC PLANS

Hussein also seriously underestimated US resolve and so was obliged to reinforce his occupation of Kuwait, awaiting "the mother of all battles." This lull provided the US Army and Marine Corps with nearly six months to build up forces in Saudi Arabia. The two most obvious coalition options for liberating Kuwait were a thrust directly into the territory, or an envelopment of it through the trackless western Iraqi desert. Hussein and many Iraqi generals did not believe the coalition forces could conduct complex mechanized operations in the deep desert, so the focus of the Iraqi

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The French 6th Light Mechanized Division with XVIII Airborne Corps was equipped with the AMX-30B2, an upgraded version of a 1960s design. (US DoD)

deployment was defense-in-depth of the Kuwaiti frontier. The Iraqi army's operational plans reflected the lessons of the Iran–Iraq War, and began with an initial line of resistance formed of second-rate regular army divisions and melodramatically dubbed "the Line of Death." A second line comprising the better regular armored divisions provided a tactical counter-attack force, and a third line of RGFC divisions provided a reserve for reinforcement and counter-attack.

Due to the limited capabilities of the regular Iraqi divisions, the Iraqi plan depended on static defense with an emphasis on the use of dug-in tanks and extensive obstacle barriers. This tactical pattern was simple enough for poorly trained troops to carry out, and it had proven very successful against Iranian infantry formations. Tanks were dug in to a hull-down position with only their

Concern about extensive Iraqi fortification of the border area led to the deployment of a variety of combat engineer devices. The Abrams can be fitted with a mine rake to hastily breach minefields, as seen on this M1A1 Abrams of the 24th Infantry Division (M) at Fort Stewart, Georgia, in 1991 shortly after returning from the Gulf War. (Author)

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turrets exposed, or were parked behind sand berms. Minefields, anti-tank ditches, and other obstructions were created along the initial line of resistance on the Kuwait frontier, and this sector was surveyed for pre-planned artillery strikes.

The tank most comparable to the M1A1 Abrams in combat effectiveness was the British Challenger I, which served with the British 1st Armoured Division on the right flank of the VII Corps assault. (US DoD)

A fatal flaw in the eventual RGFC deployment was that it stacked up three of the best heavy divisions in depth behind the Rumalyah oilfields – starting with the Tawakalna, then the Medina, and finally the Hammurabi. As a result, the US VII Corps was able to use overwhelming force to destroy the divisions piecemeal rather than confronting them simultaneously.

Although the Iraqi armed forces did anticipate a coalition air attack as part of the campaign, they had never experienced a major air assault during the Iran–Iraq War, and underestimated coalition airpower. While there were few expectations that the air defense network would shield the Iraqi army totally, Iraqi leaders did expect that it could inflict significant aircraft losses and that the Iraqi ground units could endure what survived.

THE COALITION PLAN

The coalition plan assumed that action would be taken against the Iraqi army along the Kuwaiti frontier, but that the primary thrust would be conducted into the western Iraqi desert to outflank, envelop and destroy the Iraqi army in Kuwait. The plan also included a significant deception effort aimed at convincing Hussein that the main thrust would be directed into Kuwait.

The right wing of the coalition assault into Kuwait consisted of two US Marine divisions with two Arab Joint Forces Commands (JFCs) providing formations on either side. The US Third Army controlled two corps on the left flank facing directly into the western Iraqi desert. The VII Corps was the primary heavy-maneuver force and included two US and one British armored divisions, two mechanized divisions, and an armored cavalry regiment. On the far left flank was the light-maneuver force, XVIII Airborne Corps, which included two US airborne/airmobile divisions, a mechanized division, an armored cavalry regiment, and a French mechanized division. The Third Army's two corps were deployed deep in Saudi Arabia through January 1991 and only began moving into strike position in the weeks prior to Operation *Desert Storm* in the hope of maintaining the ruse.

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A key element in the coalition plan was the incorporation of a significant pre-ground-attack air campaign to wear down the Iraq forces. This was conducted by coalition aircraft based in Saudi Arabia, from aircraft carriers in the Arabian Gulf, and from more distant bases such as the Indian Ocean island of Diego Garcia. Analysts at the time felt that a force ratio of three to one in favor of the attacker was needed to overcome a determined defense. In January 1991, Iraqi forces in the Kuwait theater enjoyed a marginal superiority in personnel, tanks, and artillery over coalition forces; the air attacks were intended to shift the balance in favor of the coalition.

T-72 TACTICAL ORGANIZATION

The Iraqi army relied on British organizational practices, with tactical doctrine also influenced by later Soviet, Jordanian, and Indian advisers, and by the experiences of the war with Iran. The basic tactical formation was the brigade (*lawae*); brigades were generally formed into divisions with three brigades per division. The brigades in turn consisted of a number of *katiba*, which is often translated as "regiment" but which in the case of armor were closer in strength to a US battalion, nominally having 55–60 tanks in three companies. The actual strength of Iraqi tank battalions is not known in detail. One battalion of the Tawakalna division had only about 40 tanks, according to its commander, and some regular army battalions only had around 35. In general, the RGFC divisions had the better equipment – usually T-72 tanks and BMP-1 infantry fighting vehicles – while the regular army divisions would have T-55, T-62 or Chinese Type 69 tanks along with Chinese armored personnel carriers or cheap

Iraqi tactical doctrine favored entrenched emplacement of tanks during defensive operations. Lacking the time to prepare deep entrenchments, many Iraqi T-72M tank crews constructed small berms around their positions using the bow-mounted scraper, but this provided no protection against APFSDS rounds. (US DoD)

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Iraqi T-72 Units in Kuwait Theater, 1991		
Brigade	**Division**	**Number of tank battalions**
12th Armored Brigade	3rd Saladin Armored Division	3
8th Mechanized Brigade	3rd Saladin Armored Division	1
8th RGFC Armored Brigade	RGFC Hammurabi Armored Division	3
17th RGFC Armored Brigade	RGFC Hammurabi Armored Division	3
15th RGFC Mechanized Brigade	RGFC Hammurabi Armored Division	1
2nd RGFC Armored Brigade	RGFC Medina Armored Division	3
10th RGFC Armored Brigade	RGFC Medina Armored Division	3
14th RGFC Mechanized Brigade	RGFC Medina Armored Division	1
9th RGFC Armored Brigade	RGFC Tawakalna Mechanized Division	3
18th RGFC Mechanized Brigade	RGFC Tawakalna Mechanized Division	1
29th RGFC Mechanized Brigade	RGFC Tawakalna Mechanized Division	1

Soviet MT-LB transporters. A few of the better regular army formations, such as the 3rd Saladin Armored Division, had at least one battalion of T-72 tanks, and conversely some RGFC brigades had T-62 tanks. A typical armor brigade would include two or three tank battalions and a mechanized infantry battalion; a mechanized brigade would reverse the balance of tank and mechanized infantry battalions. A fully equipped RGFC armored division might have about 220 T-72 tanks. Three of these RGFC heavy divisions saw combat in 1991; they were the Hammurabi RGFC and Medina–Manarawah armored divisions and the Tawakalna-al-Allah mechanized division. About 21 T-72 tank regiments saw service in the 1991 war, totaling close to a thousand T-72 tanks.

In a defensive engagement Iraqi tank regiments preferred to fight enemy tank units from static positions, due to the limitations of their small-unit training. Iraqi doctrine favored reverse-slope defense with the unit positioned down the opposite side of a hill or ridge. The aim of this tactic was to ambush an enemy tank formation as it crested the rise – the enemy's lead tanks could be picked off by the stationary tanks positioned below. At the same time, following waves of enemy tanks would be unable to locate and identify the Iraqi tanks until after they too had crested the rise, at which point they would still be vulnerable to Iraqi fire. This tactic minimized the tactical shortcomings

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of the Iraqi tankers, such as poor gunnery training, and placed minimal demands on the crew. The gunners of each Iraqi tank would be instructed in advance of the range to target, so the gun could be battle-sighted to engage at a pre-determined range without the need for range input data, which would slow a poorly trained crew. To improve their survivability, Iraqi tanks were often dug in in advance by combat engineer units, which reduced the vulnerability of the hull to enemy fire and minimized the target presented to enemy gunners. The use of prepared defensive positions was especially common among the regular-army armored divisions along the Kuwaiti border. As will be related below, the RGFC divisions in the Iraqi desert moved forward from prepared positions, but even in these circumstances the tank regiments attempted to create fixed defensive positions using available engineering assets as well as the scraper blade fitted to the front hull of the T-72.

Iraqi doctrine included a traditional combined-arms component with tank units often supported by intermixed infantry. This included dismounted infantry with large numbers of RPG-7 anti-tank rockets as well as their supporting BMP-1 infantry fighting vehicles. Likewise, Iraqi doctrine placed great faith in artillery support for forward tank positions. Despite substantial reserves of good-quality pieces, Iraqi artillery support was severely compromised by the poor quality of training and overreliance on tactics perfected in fighting Iran. The Iranian army was primarily an infantry force, so Iraqi artillery doctrine favored the use of pre-registered kill-zones that could be prepared in advance of the enemy attack and which placed very limited demands on the Iraqi fire-direction network. However, such tactics were very poorly suited to engaging a fast-moving mechanized force, as would become blatantly apparent in 1991. Iraqi doctrine did not place significant emphasis on close air support as Iraq's air force had seldom shown the capability to use such tactics. While some Mil Mi-24 attack helicopters were available in the combat theater in 1991, they played little or no role in the ground campaign, and neither did fixed-wing strike aircraft.

M1A1 TACTICAL ORGANIZATION

The first M1 Abrams units to arrive in Saudi Arabia were the battalions of the US 24th Infantry Division (Mechanized) which still had older M1 and IPM1 tanks. By November 1990 there were 580 M1/IPM1 tanks in Saudi Arabia, but only 123 new M1A1 tanks. As the likelihood of a ground war increased the army re-equipped as many units as possible with the M1A1, preferably the latest M1A1HA version. However, since there were not enough M1A1HAs available, a retrofit program was begun to upgrade M1A1 tanks with the Heavy Armor package. A total of 835 such upgrades were completed, also including fire-control upgrades, installation of an NBC-system heat exchanger, repainting with the CARC tan desert camouflage paint, and other improvements. This version had no specific designation but is sometimes referred to as M1A1 (mod) or M1A1HA; the table below lists them as M1A1 (mod)

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to identify the units that used them but elsewhere in this book they are simply called M1A1HA, since they were virtually identical in performance and features. At the start of the ground campaign only two battalions still had the M1 tank. By February 1991 the US Army had deployed 1,956 M1A1 tanks to Saudi Arabia (733 M1A1, 1,233 M1A1HA), plus 528 other tanks in war reserve stock not attached to combat units. Other upgrades were applied to the M1A1 fleet in the months prior to the fighting; this included the dispatch of the improved T-158 track.

US Army armored divisions were organized into six armor and four mechanized infantry battalions, while mechanized infantry divisions had the reverse mix of six mechanized infantry and four armor battalions. It should be noted that US heavy battalions relied on regimental lineage, so for example "2–67 Armor" refers to 2nd Battalion, 67th Armored Regiment. The armor battalions had a headquarters company with two M1A1 tanks, and four tank companies each with 14 M1A1 tanks, for a total of 55 tanks. The armored divisions were in turn each organized into three combined-arms brigades (comparable to the World War II combat command) typically consisting of two armor battalions, a mechanized infantry battalion, a self-propelled 155mm artillery battalion, and an air-defense battery along with supporting elements.

The 2nd Iron Brigade of the 1st Armored Division, featured later, provides a good example. It had three tank battalions (2–70 Armor; 4–70 Armor; 1–35 Armor) and one mechanized battalion (6–6 Infantry), supported by the 47 Support Battalion and 2–1 Field Artillery. The battalions in turn were mission-organized into combined-arms task forces. Thus, for example, Task Force 2–70 Armor (TF 2–70) comprised three Abrams tank companies – A, B, and D – and one Bradley mechanized company, C/6–6 Infantry, for a total of 44 tanks and 13 Bradleys.

In the open desert, TF 2–70 moved in a modified diamond formation. Team Bandit (B Company, 2–70 Armor) led with Team Desperado (D Company, 2–70 Armor) on the right, Team Assassin (A Company, 2–70 Armor) on the left, and Team Bayonet (C Company, 6–6 Infantry) in the rear with battalion trains and

The first division to arrive in Saudi Arabia with M1 tanks in 1990 was the 24th Infantry Division (M), which was still equipped with the 105mm M1 and IPM1 tanks, such as this tank from Company C, 3–69 Armor. The unit was re-equipped with the M1A1 later in the year. (US Army)

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headquarters in the center of the formation. Team Bandit, the focus of the duel described in the next chapter, comprised 14 M1A1 tanks, an engineer company, and an M88 recovery and medic vehicle with its remaining organic M88 and ambulance in the company trains.

The US Army also deployed two armored cavalry regiments to Saudi Arabia, the 2nd and 3rd ACR, one with each corps. Such regiments had three armored cavalry squadrons each with three armored cavalry troops with nine Abrams and 12 Bradleys. So a squadron had 41 Abrams and 32 Bradleys while the regimental strength totaled 116 M1A1 Abrams and 132 M3 Bradleys. The table below lists the squadrons as battalions for simplicity, although it should be noted that they had fewer Abrams than an armor battalion.

The US Marine Corps tank battalions in Operation *Desert Storm* were equipped primarily with the older M60A1 RISE/Passive tank, amounting to 277 of the 353 tanks deployed. The Marines were still awaiting delivery of the M1A1 Common – a modified version of the M1A1, intended to unify Army/Marine requirements by incorporating necessary Marine features such as deep-wading adapters for amphibious operations. The Marine 2nd Tank Battalion was equipped with M1A1HAs borrowed from the Army, while the two companies of the Marine Reserve 4th Tank Battalion had the new M1A1 Common tank. In total, the USMC deployed 76 M1A1 tanks in Operation *Desert Storm*, consisting of 60 M1A1HA and 16 M1A1 Common tanks.

US Army "Air-Land Battle" doctrine represented the culmination of more than a decade of intense debate over the ideal way to deal with a Warsaw Pact campaign in central Europe. Although primarily defensive in orientation, the doctrine did incorporate a strong emphasis on mobile counter-attack and extremely aggressive tactics, and due to the high level of training at all levels this could easily be adapted for an offensive campaign. The US Army doctrine greatly stressed combined arms in the broadest sense of the term. The doctrine presumed a very heavy employment of airpower to wear down the enemy forces before contact with the ground element. In addition, the US Army had invested a tremendous amount of human and material capital in building up an organic aviation element within the heavy-maneuver divisions, most notably a battalion of AH-64 Apache attack helicopters. These provided the divisional commander with a powerful air cavalry force that could provide flexible flank security during mobile operations, as well as substantial anti-armor capability, which was of particular use in close-battle conditions where the US Air Force was less comfortable operating.

The US Marine Corps relied on the older M60A1 RISE/Passive while awaiting delivery of the M1A1 tank. Many of the former type were upgraded with explosive reactive armor for added protection against anti-tank missiles. (USMC)

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The advent of the M1 Abrams tank and M2/M3 Bradley infantry/cavalry fighting vehicle was accompanied by an evolution in doctrine that increased the tempo of small-unit tactics in direct combat, since both categories of combat vehicle could now fight on the move. This tactical innovation was stressed in training since the high speed of an assaulting force could help debilitate a slower-reacting opponent, and if properly exploited, speed could reduce the attackers' vulnerability to enemy weapons. This would become very apparent in combat with the Iraqi forces, which were unable to react quickly enough to deal with the US Army's offensive tactics. The forward-maneuver units' effectiveness was further enhanced by the substantial firepower of the divisional artillery, which had undergone a renaissance in the 1970s and 1980s in terms of equipment, munitions, and fire-direction. This broad modernization of technology and tactics acrosss the US armed forces amplified the Abrams tank battalions' advantage, since the Iraqi units had often already suffered from violent preparatory attacks from US fixed-wing aircraft, attack helicopters and artillery even before making contact with US tank units. In contrast, Abrams battalions could usually operate free from enemy air attack, and Iraqi artillery posed little threat both due to inherent tactical weaknesses and short life expectancy once engaged by US counter-battery fire.

M1 Abrams Tank Battalions/Squadrons, Operation *Desert Storm*

	M1	M1A1	M1A1 (mod)	M1A1HA	M1A1 Common	Total
1st Armored Division		3	2	1		6
3rd Armored Division		3		3		6
1st Cavalry Division			4			4
1st Infantry Division	2		2	2		6
24th Infantry Division			4			4
Tiger Brigade (2nd Armored Division)			2			2
2nd Armored Cavalry Regiment				3*		3
3rd Armored Cavalry Regiment				3*		3
US Marine Corps				1	1**	2
Total	***2***	***6***	***14***	***13***	***1***	***36***

* Armored cavalry regiments were organized with three squadrons with 41 M1A1HAs each.
** Only two companies.

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THE CAMPAIGN

The air campaign began on January 17, 1991, and continued for 35 days. The US Air Force later claimed that 40 percent of the Iraqi tanks and 35 percent of the other armored fighting vehicles had been knocked out in the air attacks. However, this assessment was later judged to have been too optimistic. The US Marine Corps estimated that 10–15 percent of AFVs had been knocked out in Kuwait, while the US Army estimated about 15–25 percent in the western Iraqi desert. The lowest estimate comes from a Russian assessment that estimated 3,700 tanks in the combat zone at the outset of the air campaign and 3,400 at the end. Regardless of the precise number of tanks knocked out by aircraft, the air assault devastated the Iraqi army. The relentless bombing thoroughly demoralized the Iraqi troops and led to widespread desertion; a Russian assessment concluded that Iraqi strength in the combat zone dropped from 790,000 troops at the outset of the campaign to about 400,000 when the ground campaign began on February 24, 1991; some US estimates suggested that the Iraqi strength may have only been half this number. The air campaign also devastated the Iraqi logistics network, making it difficult to supply many units. The attacks had their greatest impact on the poorly trained and poorly motivated conscripts in the frontline divisions in Kuwait, but had far less effect on the better-motivated RGFC troops in the army reserve further back from the front lines.

G-Day, signifying the start of the ground campaign, began at dawn on February 24, 1991, with the assault by XVIII Airborne Corps, located on the western flank of the coalition. Meanwhile the Joint Forces Commands and US Marine Corps began breaching operations against the most substantial Iraqi defensive belts along the Kuwaiti frontier. Of the 36 Abrams battalions/squadrons in Operation *Desert Storm*, seven served with XVIII Airborne Corps on the left flank, 25 with VII Corps in the center, and four with the Marines on the right flank along the Kuwaiti border. Since

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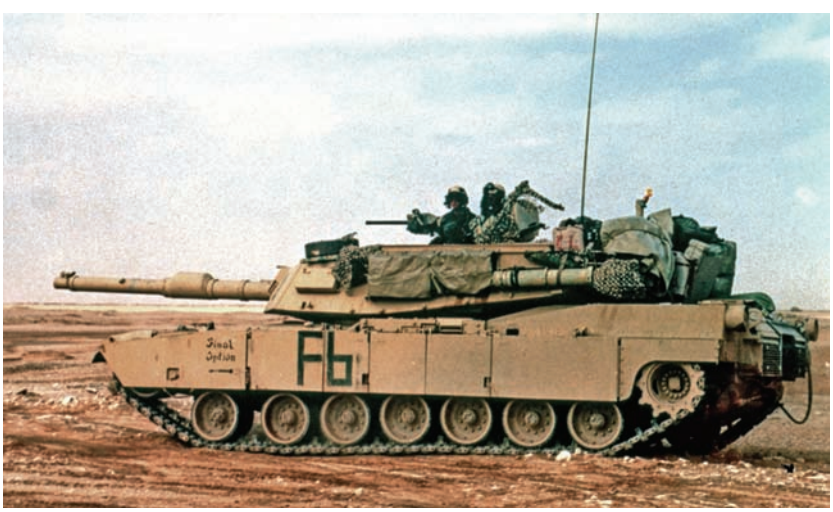
the main concentration of Iraqi T-72 tanks faced VII Corps, this sector will be the focus here.

The primary mission of VII Corps was to rapidly breach the Iraqi frontier defenses, race through the Iraqi desert to the west of the Kuwaiti frontier, then envelop and destroy the Republican Guards divisions serving as the Iraqi army's main reserve.

The original plan envisioned VII Corps beginning its attack on G+1, but the Marines' unexpectedly rapid penetration of Iraqi defenses on the Kuwaiti frontier accelerated the plan and resulted in initial breaching maneuvers being undertaken on G-Day afternoon, with the 2nd Armored Cavalry Regiment in the lead followed by the corps' heavy-maneuver divisions. This massive force overran two brigades of the Iraqi 26th Infantry Division with few signs of coherent resistance or effective artillery.

Behind the thin crust of defenses along the border was the Jihad Corps, including the 10th and 12th Armored Divisions subordinate to Gen Ayad al-Rawi, commander of the RGFC. By late on February 24, Al-Rawi was well aware of the advance of XVIII Airborne Corps, but the late launch of VII Corps, the poor weather, and the annihilation of the 26th Infantry Division left him blind to the massive force heading towards his command. The threat posed by the coalition forces prompted him to dispatch two armored brigades of the 12th Armored Division and one from the 10th Armored Division to cover the Wadi-al-Batin along the western Kuwaiti border and to serve as a shield while he re-oriented the RGFC heavy divisions towards the threat. The weather was "more like Germany than Arabia," in the words of one American tanker – cold, windy, rainy and overcast. The heaviest fighting on G+1 erupted along the corps' right flank as the US 1st Infantry Division continued the breach of the 26th Infantry Division defensive lines in preparation for exploitation by the British 1st Armoured Division. The Iraqi 7th Corps attempted to stem the advance by deploying its tactical reserve, the 52nd Armored Division, which became entangled and smashed in a one-sided night-fight with British Challenger tanks late on February 25. By midnight of February 25/26, most of the Iraqi 7th Corps had been routed.



An M1A1 named "Final Option" of F Troop, 3rd Armored Cavalry Regiment, which served with XVIII Airborne Corps on the left flank of the coalition assault. (US Army)

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The weather during the fighting in late February was mostly overcast, with frequent rain and sandstorms. This is a column of M1A1 tanks of VII Corps moving forward. (US DoD)

Around noon on February 25, G+1, 2nd ACR began to encounter advance elements of the Iraqi 50th Brigade, 12th Armored Division, and it began a one-sided engagement against a battalion of T-55 tanks and MT-LB armored transporters. The Abrams and Bradleys fought for the remainder of the day against scattered armored and infantry elements of the Iraqi division, significantly weakening one of its brigades. A small number of T-72 tanks was encountered late in the day – most likely constituting advance elements of the RGFC Tawakalna Division. The US 1st Armored Division completed the destruction of the hapless Iraqi 26th Infantry Division, overrunning its surviving brigade. For most of G+1, the long columns of Abrams and Bradleys advanced at a rapid pace, screened by scout helicopters and AH-64 Apache attack helicopters.

During the evening of February 25, VII Corps commander Gen Fred Franks approved "Frag Plan 7," which started the "great wheel" of the 2nd ACR, as well as the 1st and 3rd Armored Divisions and 1st Cavalry Division to the east along a phase-line to attack the RGFC corps. In the meantime, Gen Al-Rawi had ordered three RGFC heavy divisions to begin repositioning themselves to counter the rapidly approaching VII Corps. The Tawakalna Mechanized Division was placed in a defensive blocking position on the western Kuwaiti border, with surviving elements of the 12th Armored Division to its south, and the 10th Armored Division behind it to its east. The Medina and Hammurabi armored divisions were placed north on either side of the Rumaylah oilfields. This set the stage for the most intense tank fights of Operation *Desert Storm*.

Around 0600 on G+2, the 2nd ACR continued the advance, coming across isolated T-55 tanks and MT-LB transporters from the Iraqi 12th Armored Division's remaining brigades. The increasing numbers of better vehicle types encountered, including T-72 tanks, hinted at a growing RGFC presence. The intensity of the fighting increased to the point that the US regiment became convinced that it had finally entered the outer security zone of the RGFC Tawakalna Division. By mid-afternoon, the regiment as well as the neighboring 3rd Armored Division on their left encountered dug-in T-72 tanks and BMP-1 infantry fighting vehicles. Although much of the Iraqi army was now in full-scale retreat from Kuwait, the Tawakalna Division showed every sign of staunchly defending the line against the approaching VII Corps. Besides their own battalions, the Tawakalna Division had served as a collection point for battalions of the neighboring 12th Armored Division, which it incorporated into the defense.

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73 EASTING

The fighting intensified in the late afternoon when 2nd ACR encountered elements of the Iraqi 9th Armored Battalion and 18th Mechanized Battalion on the left flank of the Tawakalna Division, in prepared positions to the west of the IPSA pipeline. E Troop and I Troop fought a series of skirmishes from around 1530, pushing through the Iraqi position and reaching the 73 Easting gridline before being counter-attacked by a company of T-72 tanks; however, these were destroyed by M1A1 tanks at 2,100m. The Iraqi defense position lacked an adequate security zone in front, so that when the American vehicles appeared out of the rain and mist they were completely unexpected. Some Iraqi crews were huddled down in trenches due to earlier air attacks in the area, and never managed to get back into their vehicles. Other tanks did try to fight back, but their crews could barely see the attacking American force and the tanks failed to properly adjust for range, with their sabot rounds hitting the ground well in front of the US Army vehicles. As the smoke cleared, it revealed that the 18 M1A1 tanks and 24 M3A1 Bradleys had destroyed more than 30 dug-in T-72 tanks and 12 BMP-1s with no loss to themselves. The mechanized infantry battalion commander captured by E Troop said he had started the fight with 900 soldiers, a few dozen BMP-1s and an attached battalion of 36 tanks; when he was captured all that survived were the 40 soldiers with him. A stunned Tawakalna tank battalion commander added: "When the air campaign started, I had 39 [T-72] tanks. After 38 days of the air battle, I had 32 tanks. After 20 minutes against them [the 2nd Armored Cavalry Regiment], I had zero tanks." After dark, 1–1st Aviation's

A T-72M tank of 3rd Saladin Armored Division, knocked out during the fighting near Ali-al-Salem airbase by an APFSDS hit near the rear turret bustle. (US DoD)

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Apache helicopters struck the second tactical echelon of these brigades, causing heavy losses to three emplaced battalions.

As contact with the Tawakalna Division developed, the US 1st Infantry Division passed through the overworked 2nd ACR in the dark to prepare for the following day's attack. In the process, two Bradleys conducting forward reconnaissance were silhouetted against the skyline by the burning wrecks of Iraqi vehicles and were hit by vehicles of the RGFC 18th Mechanized Brigade. The 3rd Brigade, 1st Infantry Division confronted an Iraqi regiment shortly before midnight along the IPSA pipeline and destroyed about 60 tanks and 35 infantry vehicles. The battlefield was littered with destroyed Iraqi equipment, burning wrecks, hidden Iraqi tanks in revetments, and roaming Iraqi RPG anti-tank rocket teams. One Abrams battalion remembered it as "fright night." During the fighting, M1A1 tanks on several occasions mistakenly engaged friendly forces, knocking out five other M1A1 tanks and two Bradleys; fratricide proved more costly than Iraqi actions. Friendly-fire incidents would continue to be a significant hazard because of the way US and Iraqi forces were intermingled, as well as due to the chaotic battlefield being obscured by darkness, rain and sandstorms. By dawn of G+3, the 2nd ACR and 1st Infantry Division had destroyed most of four Iraqi tank and mechanized brigades and had cracked open the left flank of the RGFC defenses.

In the center, the US 3rd Armored Division hit the right flank of the Tawakalna Division in the late afternoon of G+2, where about eight Iraqi tank and mechanized battalions, with 122 tanks and 78 BMPs, were pitted against ten US heavy battalions. The fighting was not entirely one-sided. A troop of Bradleys from 4–7 Cavalry engaged a well-entrenched Iraqi position and nine of its 13 Bradleys were damaged before the unit withdrew; two more fell victim to friendly fire. Indeed, the

A US Marine M1A1HA with mine plows passes a revetted Iraqi truck. The Marine 2nd Tank Battalion borrowed M1A1HA tanks from the army until the M1A1 Common became available after the conflict. (USMC)

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Iraqi resistance was fierce enough that 1st Brigade, 3rd Armored Division temporarily halted the attack that night. The neighboring 2nd Brigade fought its way through much of the Iraqi 29th Mechanized Brigade defenses by the early hours of February 27.

The right flank of the Tawakalna Division – a tank battalion of the 29th Mechanized Brigade supported by a BMP company – was overwhelmed on the evening of February 26 by the 3rd Brigade, 1st Armored Division, with 24 T-72s and 14 BMP-1s knocked out. Four M1A1 tanks were mistakenly hit by Hellfire missiles from Apache helicopters but without crew injuries. The division's other two brigades continued to advance eastward that night, aiming at the RGFC Medina Division.

By midnight of G+2, after less than 30 hours of fighting, the Tawakalna Mechanized Division had been destroyed bit by bit by the overwhelming force of three US Army heavy divisions and the 2nd ACR. In contrast to press accounts which suggested that most Iraqi units "bugged out" and ran at the first opportunity, the Tawakalna fought tenaciously; nevertheless, its sacrifices were largely in vain due to its poor tactical skills.

MEDINA RIDGE

On VII Corps' left flank, two brigades of the US 1st Armored Division continued to move forward on the night of February 26/27 in anticipation of encountering the RGFC Medina Armored Division on the outskirts of the Rumalyah oilfields. Gen Al-Rawi had dispatched a brigade of the Adnan Motorized Division to serve as a covering force, but this was identified during its movement forward and shattered by US artillery fire. By the morning of February 27, the 1st Armored Division had called a halt for refueling – M1A1 Abrams tanks typically refueled three times a day during the operation due to the distances covered. In the midst of this operation, 2nd Brigade was brought under intense artillery fire by the Medina Division's artillery regiment, but the Iraqis only struck pre-registered boxes and did not adjust their fire, so 2nd Brigade emerged from the barrage unscathed. This was typical of Iraqi artillery which had excellent and plentiful weapons but poor fire-direction skills.

The Medina Armored Division's 2nd Armored Brigade had established a reverse-slope defense; however, the site had been poorly chosen, as the ridge that the brigade was using to ambush the advancing US force was too far away for its 125mm guns to reach, as the Iraqis had apparently not bothered to verify the distance. The weather was overcast and wet with visibility at only about 1,500m. The US 1st Armored Division's 2nd Iron Brigade crested the rise shortly after noon on February 27. The Iraqis were unaware of their arrival, lacking a proper security zone and unable to see the Abrams due to the weather. The stage was set for the Battle of Medina Ridge, as recounted by Capt Gerges, who led Team Bandit of TF 2–70 during the engagement.

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ABRAMS VS T-72 AT MEDINA RIDGE, IN CAPT MARK GERGES'S OWN WORDS

The Iraqis moved into position the day before to protect the withdrawal of Iraqi forces from Kuwait by covering the road along the Kuwaiti border. Oriented west in a generally north–south axis, the brigade was at 75 percent strength and consisted of T-72M1s and BMP-1s. The crews constructed hasty fighting positions by pushing sand up around their vehicles with attached scrapers so that only their turrets were visible, yet the entire vehicle extended above the desert floor. In reserve to the rear was a BMP-1 company; air defense and command-and-control vehicles were dotted along the position. Overestimating American capabilities in electronic warfare, the forward recon screen deployed with their radios off. Consequently, when TF 2–70 and 4–70 destroyed the screen at 0700, the presence of the Americans went unreported. The Iraqis had no idea that enemy forces were so close. At 1130, the Medina brigade cooked rice and chicken on small one-burner stoves near their vehicles.

American movement began at 1145, and leading the company was 1st Platoon under Lt Matt Howson in tank B11. As B11 crested a small wash less than 20 minutes later, the driver suddenly slammed on his brakes lifting the rear of the tank into the air from the sudden halt. Almost immediately Lt Howson called "Contact, tanks, east" over the company net and backed into a hull-down position. Two T-72s and a BMP were oriented north, unaware of the American tanks. Howson's gunner, Sgt Manning, could see the crews on the back deck of the tanks. The other American tanks in Team Bandit pulled into positions to the left and right of B11 and observed additional targets to the east. Simultaneously, Capt Mark Gerges's B66 sent a contact report to the task-force commander requesting confirmation that there were no friendly vehicles to the front. Receiving immediate confirmation, the first tanks began firing at the Iraqi vehicles. Team Assassin to the north also reported tanks and BMPs to their front. The time was 1217.

A column of 2–70 Armor advancing during the fighting on Medina Ridge with Lt Steve Whitcomb's M1A1, named "Tiger," in the foreground. (Mark Gerges)

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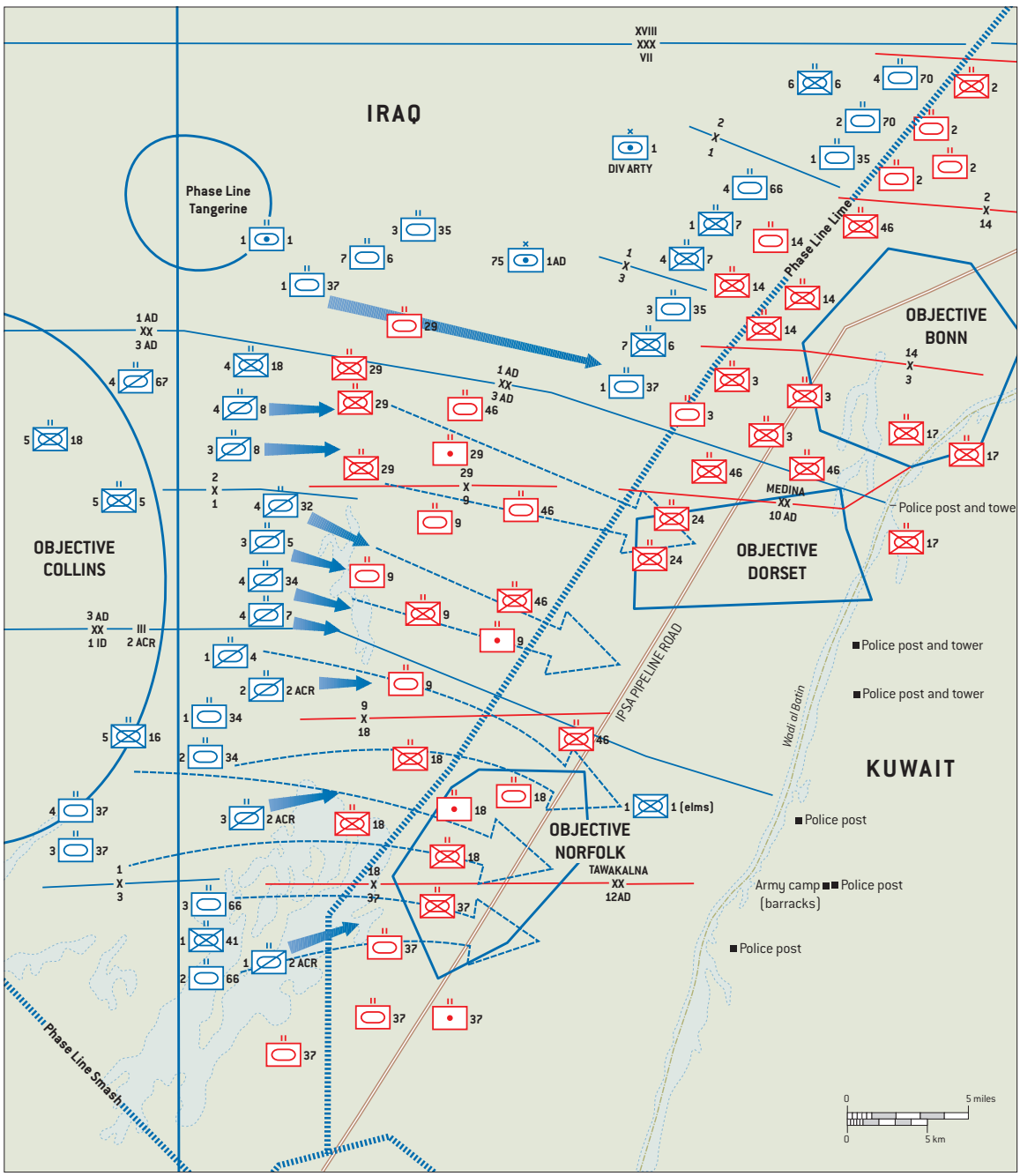
ATTACK ON REPUBLICAN GUARD CORPS BY VII CORPS, NIGHT OF FEBRUARY 26 TO NOON, FEBRUARY 27, 1991



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"Assault, assault, assault!" This remarkable photograph was taken by Capt Mark Gerges from the turret of his tank as Team Bandit overran the Iraqi 2nd Armored Brigade positions on Medina Ridge. The flaming debris appears to come from an SA-13 air-defense missile vehicle behind a berm and camouflage net, and the advancing line of M1A1 tanks can be seen beyond. (Mark Gerges)

The Abrams gunners saw hotspots through their sights at a range of nearly 3,000m. Invisible to the naked eye because of the weather, turrets showed up clearly above the sand berms surrounding each vehicle as did individual crew-members as they moved about. Laser rangefinders reported ranges of 2,800–3,200m and the tanks alternated firing so that wingmen could observe the splash of a round and call out adjustments if needed. There was little need. The depleted-uranium sabot rounds flew practically flat in the two to three seconds it took them to reach the T-72s. There was no arch to the sabots' trajectory as there had been with training ammunition during gunnery practice in Germany. As a round struck a target, crews observed a flash through the thermal sight from the pyrophoric effect as the depleted-uranium penetrator struck the armor.

The experience of B66 under Capt Gerges in the center of the Bravo Company's line was typical. The tank gunner, Sgt Jerry Reynolds identified tanks on the ridge in front of the tank. The tank commander, Capt Gerges, issued the fire command "Gunner, sabot, tank" that began the crew's drill. B66 normally "battle-carried" a sabot round; this meant that a round was in the breech of the gun and the gunner pre-selected sabot as the ammunition type. All that was required was for the loader, PFC Bowie, to verify that the correct type of round was loaded, move his body from the path of the breech's recoil, and arm the gun, shouting "Up!" As this occurred, Sgt Reynolds selected a target through the thermal sight in 10-power, announcing "Identified," and ranged to the target with the laser rangefinder. After verifying the range, the tank commander, Capt Gerges, ordered "Fire." The gunner said "On the way" and pulled the trigger. The dust kicked up from the muzzle blast obscured the target for a second or two, but crews could normally see the tracer of the round flying to the target. After two to three seconds a flash showed that the round had struck the T-72. The American crews trained to fire center-of-mass as their sight-picture, so the sabot rounds often hit the sand berm directly in front of the tank and passed completely through the vehicle, causing a catastrophic kill. As the crews continued to

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engage the fire commands become more concise, with the tank commander and gunner discussing which target to fire at next. The driver, PFC Eugene Mendoza, attempted to assist in sensing the round and making no sudden vehicle movements as the gunner squeezed off the round.

After the first few rounds the crews began to notice a series of flashes from the Iraqi positions. Looking like the Hoffman charges used in tank maneuver training, the flashes appeared roughly simultaneously in groups of eight to ten. After observing this phenomenon two or three times and then splashes of sand a kilometer to their front, the crews realized what they were – Iraqi tank companies firing blindly in volley at the American muzzle flashes. The Iraqi crews had rushed to their vehicles and returned fire, but lacking thermal sights they could only fire at the muzzle flashes in the distance. This essentially blind fire often fell a kilometer too short of the American positions. Launches of AT-3 Sagger missiles from BMPs added to the Iraqi response. The missile left a telltale smoke trail, and American crews later remarked that the launches looked exactly like the Saggers in peacetime SIMNET training in Germany – a testimony to how well the simulator replicated the real missile. Trained to fire at the launch site, one or two M1s would immediately slew their turrets and fire the main gun at the BMP-1, killing the operator guiding the missile before it could cross the 3,000m to the American positions.

The thermal sights picked up heat rising from the turrets of the T-72s hit moments before. Shortly after, the first large explosions occurred – fire caused by sabot penetrations "cooked off" the T-72 ammunition located in the autoloader under the center of the turret. The spectacular and catastrophic explosions often lifted the turrets 30–40ft into the air and tore the vehicles apart. The American firing line was now three battalions of 2nd Brigade on line, and in the distance, smoke plumes from

The view of a destroyed T-72M1 of the Hammurabi Division from an AH-64 Apache attack helicopter of 1–24 Aviation during the March 2 fighting. High-angle impacts from the Apache's Hellfire missiles struck downward near the turret ring, causing rapid and catastrophic detonation of the ammunition stowed in the carousel under the turret. (US Army)

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burning T-72s marked the horizon of the area later known as Medina Ridge. Within 15 minutes of the start of the duel 37 plumes rose across the front.

The Iraqi crews fought back in vain as other elements of their brigade tried to stem the tide. Iraqi artillery, fired blind at pre-planned targets, landed within a few hundred meters of the company trains located a kilometer behind the firing line. Nearly 400 rounds rained down during the engagement, but the undirected fire failed to shift to the American vehicles. In an effort to outflank the American line, the BMP-1 company in the Medina brigade reserve maneuvered to the north. They never made it. Zigzagging furiously, ten vehicles became nine, then eight as the M1A1s' fire took its remorseless toll. The final BMPs died on the northern extremity of the Medina's position.

Thirty-five minutes from the first contact, the momentum of the battle slowed. The 2nd Brigade commander, Col Montgomery Meigs, used the time to call in artillery, Apache helicopters, and A-10 Warthogs to attack a reported 40-plus tanks located a few kilometers from the engagement. Finally, not wanting to lose the initiative, he ordered the brigade to assault the Iraqi positions. The command of "Assault, assault, assault" has particular meaning to tank crews, with much the same resonances as "Fix bayonets" has for dismounted infantry. Advancing in line, all weapons on board the vehicles fired; the massive firepower generated by over 120 M1A1s had a shock effect on Iraqis already battered by the main-gun engagements.

As the TF 2–70 line moved forward, guiding on Bravo Company for orientation, loaders loaded one last sabot round and then stood on their seats to man their machine-guns on the skate mount outside the turret. Tank commanders prepared the M2 .50cals, and gunners scanned the front looking for targets to engage with either main guns or co-ax machine-guns. The assaulting line guided slightly southward to clear a pipeline complex to the north, 3km behind the Iraqi positions. Moving forward, Iraqi vehicles hidden from sight by the ground suddenly came into view. Many were BMP-1s and SA-13s thought to be part of the brigade's command and headquarters; never stopping, M1A1s destroyed these vehicles by gunfire. Others were T-72s that had abandoned their positions in panic. These were destroyed as well. American tanks were soon within 600m of the main Iraqi defensive positions, and the crew's machine-guns engaged individual infantry fighting positions. Burning tanks and BMPs littered the ground with tank turrets sometimes 40m away from the vehicles. As B66 approached the Iraqi line, the crew saw what looked like little white paper scraps waving in the breeze from one berm. As the tank approached, a group of 21 infantrymen suddenly stood up from the position, hands above their heads, to surrender. Tank B12 initially safeguarded the prisoners until the Bravo Company First Sergeant, Walter Wallace, and the maintenance team moved forward to secure them. The appearance of these prisoners stood in stark contrast to others captured during the past two days. While the regular army soldiers at Al-Bussayah wore dirty uniforms, were unkempt and unarmed, the Medina soldiers stood up with AK-47s in their hands, held over their heads. Load-bearing equipment was on and buckled, chinstraps on the helmets fastened, and their uniforms clean.

Within the Medina battle positions vehicles continued to burn, and American tank crews learned not to stop near a burning vehicle as the ammunition often

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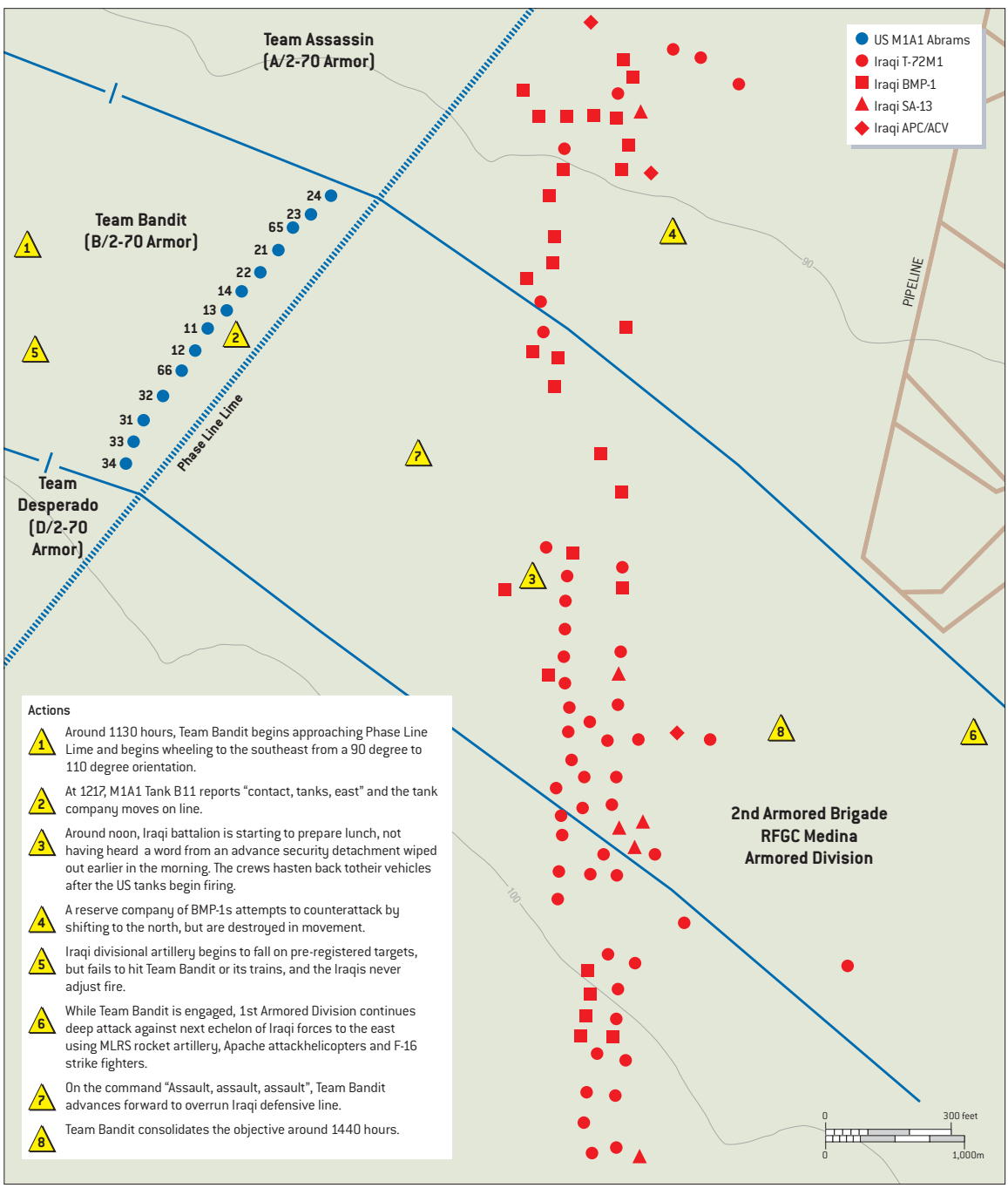
TEAM BANDIT, 2–70 ARMOR, MEDINA RIDGE, FEBRUARY 27 1991


Team Assassin
(A/2-70 Armor)
Team Bandit
(B/2-70 Armor)
Team
Desperado
(D/2-70
Armor)
Phase Line Lime
24
23
65
21
22
14
13
11
12
66
32
31
33
34
US M1A1 Abrams
Iraqi T-72M1
Iraqi BMP-1
Iraqi SA-13
Iraqi APC/ACV
PIPELINE
90
100
2nd Armored Brigade
RFGC Medina
Armored Division
0
300 feet
0
1,000m
Actions
1 Around 1130 hours, Team Bandit begins approaching Phase Line Lime and begins wheeling to the southeast from a 90 degree to 110 degree orientation.
2 At 1217, M1A1 Tank B11 reports "contact, tanks, east" and the tank company moves on line.
3 Around noon, Iraqi battalion is starting to prepare lunch, not having heard a word from an advance security detachment wiped out earlier in the morning. The crews hasten back totheir vehicles after the US tanks begin firing.
4 A reserve company of BMP-1s attempts to counterattack by shifting to the north, but are destroyed in movement.
5 Iraqi divisional artillery begins to fall on pre-registered targets, but fails to hit Team Bandit or its trains, and the Iraqis never adjust fire.
6 While Team Bandit is engaged, 1st Armored Division continues deep attack against next echelon of Iraqi forces to the east using MLRS rocket artillery, Apache attackhelicopters and F-16 strike fighters.
7 On the command "Assault, assault, assault", Team Bandit advances forward to overrun Iraqi defensive line.
8 Team Bandit consolidates the objective around 1440 hours.

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A T-72M1 of the Hammurabi Division that "lost its cap" during the fighting with the 24th Infantry Division (M) along the causeway on March 2; two burnt-out BMP-1s are also evident. (US Army)

unexpectedly cooked off. Next to some vehicles, small stoves boiled away full of rice and chicken – a testament to how quickly the end had come for the Iraqi soldiers.

The T-72 combat positions, spread about 75–100m apart, were strewn with the wreckage from the vehicles. The destruction was amazing but uneven. One turret might be in pristine condition, without a burn mark on it, except that it was 50m in front of its hull. Another turret might be slightly cocked off its turret ring, yet burnt out with only the major metal structure surviving. Some tanks had tried to run, backing out of position and turning to the rear before an American sabot round brought about their destruction. On one T-72 you could trace the flight of the sabot round through the sand berm to the front, through the front glacis plate, and out the back of the vehicle. The force of the explosion had blown the transmission out of the back of the vehicle, turning it upside down and throwing it 15ft from the tank.

To the north, the destruction of the reserve BMPs could be traced. From the rear of the Medina position a series of ten parallel APC tracks moved northwest. The BMPs advanced through a series of 45-degree turns intended to throw off American anti-tank guided missiles, but these maneuvers proved useless against tanks firing sabot rounds. The wreckage told the story of the failed counterattack. Suddenly one BMP fell, hit by a sabot round. A couple more zigs and zags and a second, third, and fourth BMP burned, until finally the survivors went to ground and were destroyed. The fins of M829 sabots, entering the thin armor of the engine cover, did not even distort. Holes made by the fins were clearly visible in the BMPs' engine compartment armor. Ripping through the vehicle, rounds exited the rear crew doors, but the fire caused by the ignition of the ammunition and fuel ripped the rear doors open, and created a huge debris field extending 50ft or more behind the BMP. Iraqi losses to Bravo Company in this sector were 12 to 18 T-72s, 12 BMP-1s, 1 BTR, two to three BRDMs, and one AMX-10RC; TF 2–70 as a whole was credited with 59 T-72 tanks, 29 BMP-1s, six SA-13s, and four other armored vehicles.

After briefly consolidating on the position, 2nd Brigade moved further east five or six kilometers, halted to refuel and prepared to continue the attack.

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THE MEDINA AND HAMMURABI DIVISIONS

A similar situation prevailed in the US 1st Brigade sector facing the Medina's 14th Mechanized Brigade and elements of the 46th Mechanized Brigade of the 12th Armored Division, which were engaged at ranges of 4,000m using thermal sights while the Iraqis were in the process of re-arming and refueling their vehicles. The Iraqi units were unprepared for the attack and generally oriented towards the south instead of facing west, from where the attack emanated. The US 1st Armored Division's 3rd Brigade was the last to crest the ridge around 1300; it encountered the 2nd Mechanized Brigade and methodically destroyed it with long-range gunfire from the M1A1 tanks and TOW missile fire from the Bradleys. By the end of February 27 the 1st Armored Division had largely destroyed the Medina Division, knocking out 186 tanks and 127 armored infantry vehicles.

The third echelon of the RGFC was the Hammurabi Armored Division, which was further west behind the Rumalyah oilfields. This division did not engage US ground forces prior to the ceasefire. However, on the morning of March 2 a significant portion of the division attempted to escape north via an elevated causeway over the Hawr-al-Hammar waterway and through a sector controlled by the US 24th Infantry Division. The Hammurabi Division had apparently been ordered by Hussein to escape out of the Basra pocket, as it was needed to help suppress the revolts that were occurring in the Shi'ite regions of southern Iraq. The column was desperate enough to fire on the Bradleys of TF 2–7 Infantry and Abrams of TF 4–64 Armor, in violation of the ceasefire. The 24th Infantry Division responded by sealing off the causeway using artillery-fired mines, then proceeded to methodically destroy the column. The division's Apaches struck with 107 Hellfire missiles, scoring 102 hits; the column was then overrun by Abrams and Bradleys with the "Battle of Rumalyah" ending in the early afternoon after 187 Iraqi armored vehicles, 34 artillery pieces and 400 trucks had been destroyed. US losses consisted of a single Abrams, burnt out after being set on fire by a massive explosion from a nearby Iraqi vehicle. This constituted the last tank engagement of Operation *Desert Storm*.

The US Marine Corps experience with the M1A1 in *Desert Storm* largely mirrored that of the Army, though on a much smaller scale. Bravo Company of the Marine 2nd Tank Battalion had at least one violent confrontation with T-72 tanks of the 3rd Saladin Armored Division in the pre-dawn hours of February 25. The company was coiled up in night defensive positions with a single crewman in each tank assigned to keep watch using the tank's thermal sight. An Iraqi T-72 battalion supported by BTR-63s (Chinese-built YW531) armored personnel carriers blindly approached the Marine defenses. An Iraqi lieutenant later recalled what ensued: "Our column was headed across the desert when all of a sudden, the tank in front of me, to the left of me, and behind me, all blew up." The lieutenant ordered his own crew to abandon their T-72, but before the men could do so their tank exploded. The lieutenant, standing in the open hatch, was blown free from the tank but the gunner and driver were killed instantly. In 90 seconds, 34 out of 35 T-72 tanks were knocked out, and then the Marine Abrams turned their guns on the poorly protected armored personnel carriers. One Marine crew was credited with hitting seven T-72 tanks with seven rounds in about a minute's time.

OVERLEAF: "Contact, tanks, east!" This radio message around noon on February 27 started an engagement between Team Bandit of Task Force 2–70 Armor and elements of the 2nd Armored Brigade of the Medina Division. The Iraqi formation, a mixture of T-72M tanks, BMP-1 infantry fighting vehicles, and assorted light armored vehicles, were positioned near a slight rise in the flat desert which was subsequently dubbed "Medina Ridge." Team Bandit spotted the Iraqi armored vehicles from a range of about 3,000m (1.8 miles) and began engaging them almost immediately. At such a range, the US tanks were essentially invisible to the Iraqi tankers due to the weather conditions and the inadequate fire controls of the T-72 tank. About the only things the Iraqis could see were the violent flashes when the Abrams tanks fired their main guns as seen here in this illustration of the engagement. This huge flash was visible at long range, but it did not provide the Iraqis with enough range data to accurately aim their 125mm guns.

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ANALYSIS

The tank fighting during Operation *Desert Storm* represented one of the most lopsided contests in 20th-century military history. The Iraqi army was outclassed in all respects and suffered appallingly high losses while inflicting minimal casualties on the coalition forces. In the case of the M1A1, more Abrams tanks were destroyed by friendly fire than Iraqi action. From later accounts it would appear that at least seven Abrams were hit by T-72 gunfire; one was temporarily disabled when a hit near the rear of the turret ignited crew stowage, and another may have been disabled by a shot through the thin armor of the engine compartment; however, no hits penetrated the frontal armor. Iraqi T-72 losses have never been tallied with any precision but were probably in the neighborhood of 750–800 tanks; total Iraqi tank losses to all causes were 3,200–3,900 plus 2,400–2,750 other types of armored vehicles lost. These T-72 losses were not exclusively to engagements against the M1A1 Abrams tank, but a significant portion were due to direct combat and not air attack.

The Iraqi T-72M1 tank performed poorly due to technical, tactical and training problems. On the firepower side, it was incapable of acquiring targets at worthwhile battle ranges, especially at night or in poor weather, and its gun/ammunition combination was incapable of penetrating the frontal armor of the Abrams. Better ammunition might have helped on the rare occasions when hits were scored, but the central problem was the lack of hits against the opposing M1A1 tanks. This was the result of both technical and training failures, and the T-72's fire controls were too complicated for rapid use by typical Iraqi crewmen. On the defensive side, the T-72's armor was vulnerable to the Abrams 120mm gun and its unshielded ammunition meant that penetrations usually led to catastrophic fires which incinerated the tank, often too quickly for the crew to escape. These spectacular explosions were profoundly demoralizing to the crews of neighboring tanks, who sometimes abandoned their own

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The Iraqi T-72M1 was overmatched during Operation *Desert Storm* not only due to the technical advantages enjoyed by the M1A1 Abrams, but more importantly due to the disparity in crew performance, tactics and training compared to their American opponents. This T-72M1 belonged to the 2nd Armored Brigade of the Medina Armored Division and was knocked out at Medina Ridge by Team Bandit, 2–70 Armor. (Mark Gerges)

vehicles after witnessing such frightening conflagrations. On the training side, the Iraqi army was completely unable to operate effectively against a well-trained opponent operating at a much faster battle tempo; tactical success was not within its grasp since units were chronically unable to carry out ordinary tasks such as establishing security zones or conducting reverse-slope defenses even when they had the time and resources to do so. The popular perception that the Iraqi soldiers simply ran away from the fight was certainly not true of the troops of the RGFC heavy divisions, who fought bravely, though ineffectively, during the fierce clashes of February 25–27.

The success of the M1A1 Abrams in the 1991 Gulf War was as much about the qualities of the crews as the technology; the Marine Corps' old M60A1 tanks performed well and many US tankers argued that they would have triumphed against the Iraqis even if the equipment had been swapped. While the US Army might indeed have triumphed with older equipment, the superb protection of the M1A1 saved lives. Innovations in the M1A1 design had significant tactical effects, contributing to the fast tempo of operations and the ability to operate during the day or at night even in poor weather conditions. The 120mm gun and the associated fire-control system was stunningly lethal and this was the first war that saw tanks firing accurately on the move on a routine basis.

The Gulf War was also the first war to see the extensive use of thermal imaging sights; this technology alone was a major factor in the ability of US heavy-maneuver battalions to fight 24 hours a day and to stand off and destroy Iraqi units during poor daytime weather when targets were otherwise not visible. The primary lessons learned from tank battles in World War II had been that the side that found the enemy first, engaged first, and hit first was most often victorious. The turbine engine, for all the headaches caused by its prodigious fuel consumption, provided the Abrams battalions with the effortless speed to smash through Iraqi defensive positions before they could react.

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